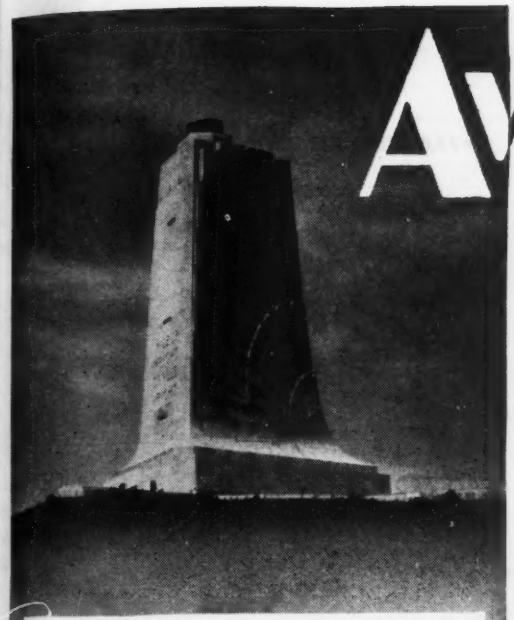

AVIATION

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Aviation is indexed in Readers' Guide to Periodical Literature and in Industrial Arts Index.

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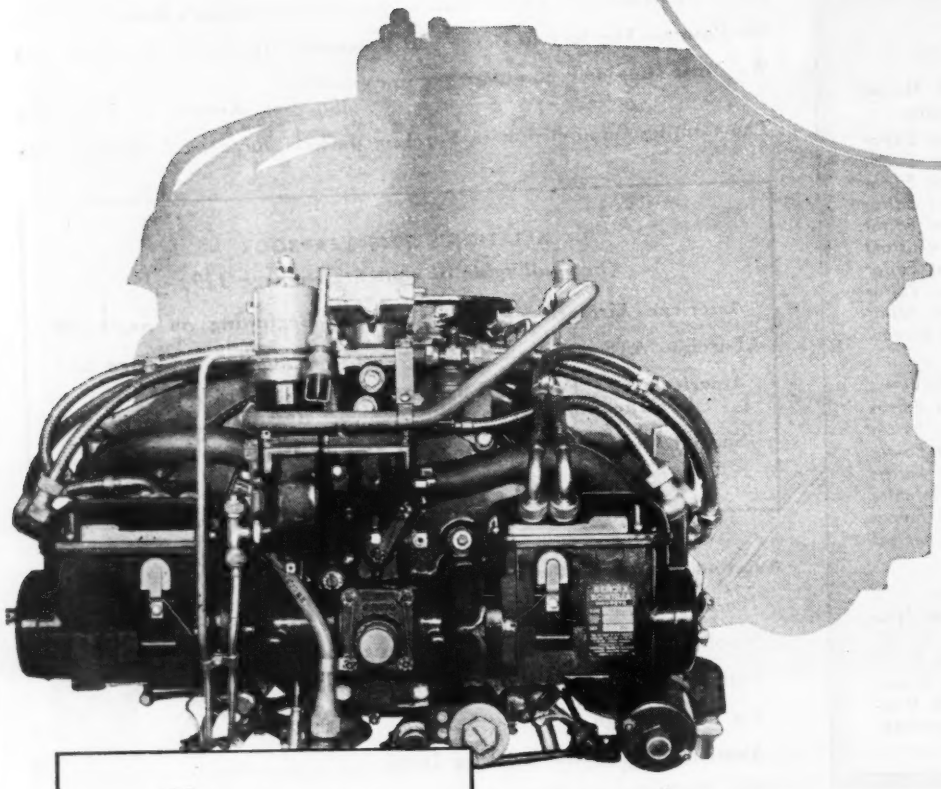

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"Working Power" teamed with "Fighting Power"

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ARMY E NAVY

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SIDNEY, N. Y.

Briefing for February

For the 12th straight year, the editors are proud to present their biggest special issue—this, the Yearbook. A total of 115 American types are presented in engineering three-views, photographs and text. This section includes 17 helicopters now in design, under construction or flying. Altogether 200 different American, Allied, and enemy types are portrayed, including 25 of the Nip's newest, many of which are sketched and described publicly for the first time. And again AVIATION presents its aircraft and engine specification tables, a job unmatched in the aviation publishing field. This year the tabulations include the first specification tables ever published on helicopters, and the most comprehensive job yet done on Jap planes. The Yearbook starts on page 119 with a special table of contents for the section, which includes 15 pages of AVIATION'S Sketchbook of Design Detail.

As ye editor sagely points out in his editorial, these are most important days for the aircraft industry and the future of America, for it is now that aviation policies must be established. Perhaps no one is better fitted than Gene Wilson, president of the Aero Chamber and vice-chairman of United Aircraft Corp., to analyze the problems facing the industry and the country. On page 110 he presents graphically those components for a national air policy that might well provide the foundation for a lasting peace.

Where and how to sell airplanes—and everything that goes with airplanes—presents plenty of problems for all management. Biggest of the problems, of course, is knowing the competition. Our financial editor supplies some of the answers in the second part of an invaluable series; this month's article starts on page 116.

The mass of propaganda and confusing reports about the Nazi's V-2 rocket bomb seem to have muddled the picture badly, so much so that it's well nigh impossible to tell whether it is really a potent weapon or just a topic for Jojo Goebbel's mouthings. So we asked Willy Ley, who's been a student of rocket propulsion for many years, to appraise the thing, not only as a material of war, but as a phase of aeronautics. You'll find "Evaluating the Vaunted V-2" intriguing reading; it begins on page 212.

We're particularly pleased with a new series which leads our Maintenance Section this month, for it's of value to personal plane owners, fixed base operators—anyone who wants to get maximum efficiency from his aircraft. The complete series will be a veritable handbook on engine trouble-shooting and overhaul, one that'll be good for years, because it gets down to principles. "Al" Lindsley, who did the series, has serviced big and little engines all over this country—and other places too—and speaks from experience. Since he's one of those men who's really interested in engines, he writes about them in a thoroughly interesting way. "What Makes Expert Mechanics *Expert?*" starts on page 216.

MAJ. GEN. KENNETH B. WOLFE, who heads ATSC's Engineering & Procurement Division, is one man who really knows the value of getting and staying out in front with technological developments, for he was the 20th Bomber Command's first "head man." On the basis of long experience in the development of aircraft, Gen. Wolfe tells — on page 113 — just "Why We Must Retain Technological Supremacy." (ATSC photo)

Another addition to the literature on compressibility is among our features this month—in Aviation's For Better Design Section, beginning on page 223. There you'll find a discussion of the design, construction, and high utility value of the recovery dive flaps now going on Republic P-47 Thunderbolts.

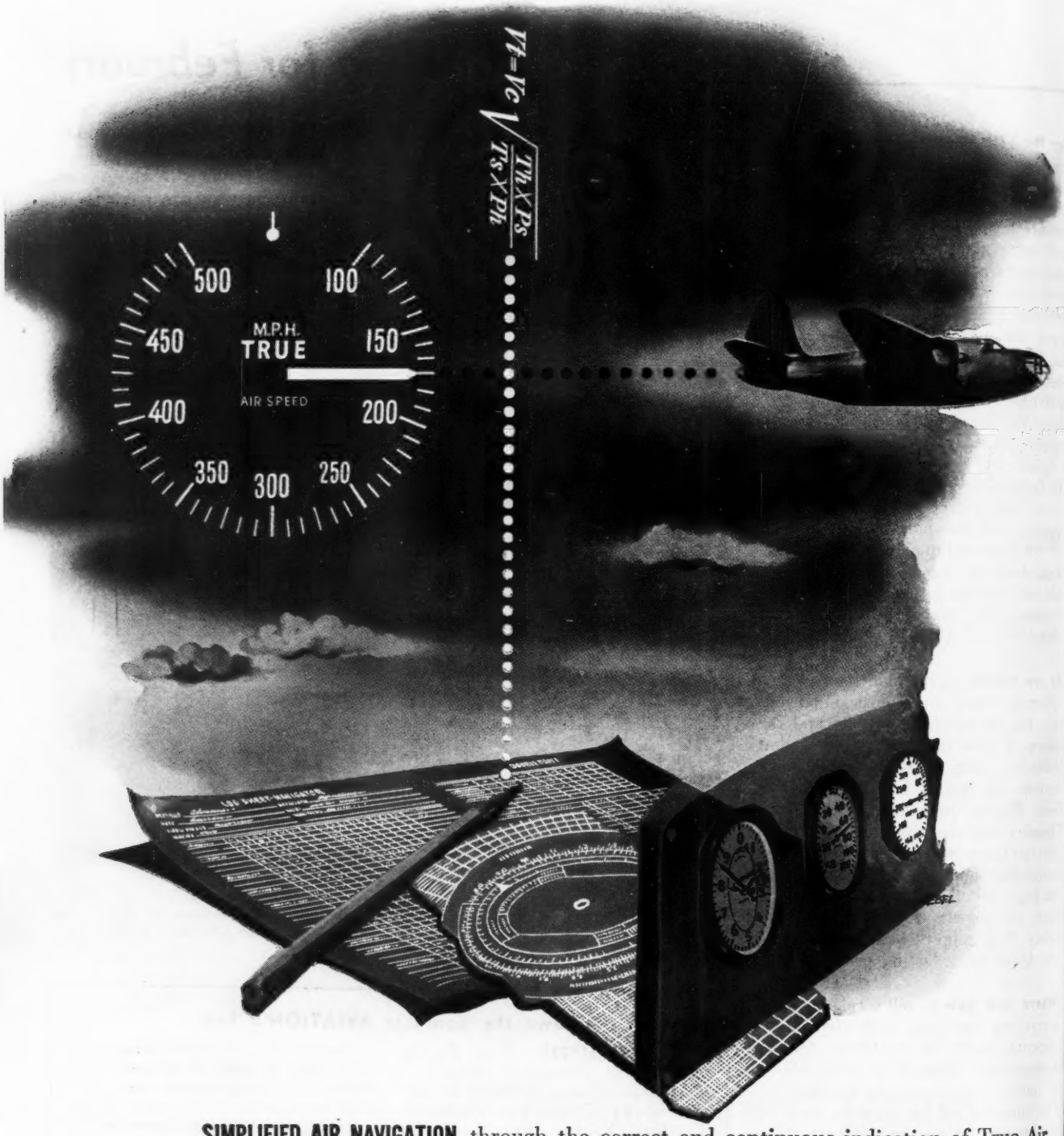
Two-place P-51 specially built for tests is demonstrated for Aviation's Bill Nelson (behind Test Pilot Bob Chilton). Reported Bill, "Whooeee!"

Down the Years in AVIATION'S Log

25 Yr. Ago (1920)— First Paris Aeronautical Exposition opens. . . . Post Office requests $3,000,000 for airmail routes: Chicago-San Francisco; Pittsburgh-Kansas City; N. Y. C.-Washington - Atlanta; Minneapolis - Chicago-St. Louis. . . . Curtiss, Aeromarine, and Boeing ship 11 flying boats, valued at $500,000, to China for French air service linking Hong Kong, Macao, and Philippines. . . . Zeppelin builds 4-engine 120-ft-span monoplane flying boat. . . . Germany's Lt. Liebman flies to 9,620 metres, breaking altitude record. . . . Anzani builds 20-cyl., 600-hp., water-cooled twin-row radial engine. . . . Navy asks $636,000 for building two seaplanes, twice size of any in existence. . . . Congress bars export of helium.

15 Yr. Ago (1930)— Bernard flies 1,000-hp. monoplane 310 mph. at Bordeaux . . . San Francisco plans $2,000,000 airport. . . . Mitchel Field experiments with directional radio. . . . Delta cuts air rates 50 percent. . . . Boeing Air Transport opens new operating headquarters at Cheyenne, Wyo. . . . NAT and TAT test Sperry artificial-horizon instrument in service. . . . N. Y. C. police department forbids proposed airmail pickup from skyscraper roof. . . . British organize glider association. . . . France proposes grant of $81,900,000 for military and naval aviation.

10 Yr. Ago (1935)— ICC recommends revision of airmail rates. . . . Navy orders 84 scout-bombers from Chance Vought. . . . Amelia Earhart flies solo from Honolulu to Oakland. . . . All American Air Races held at Miami. . . . Maj. Doolittle flies two passengers coast-to-coast in 11 hr. 59 min. . . . France's Raymond Delmotte flies Caudron-Renault at 314 mph. . . . Lt.-Col. Andrews becomes commander of GHQ Air Force.



SIMPLIFIED AIR NAVIGATION, through the correct and continuous indication of True Air Speed, is the latest result of Kollsman's development program. The new True Air Speed Indicator—a combination Airspeed, Altimeter and Thermometer in one interacting assembly—eliminates the separate reading of these instruments and the involved calculations formerly required, yet gives a direct reading more accurate than can be computed. By ridding long-range air navigation of this source of error, Kollsman makes another important contribution to future aviation progress.

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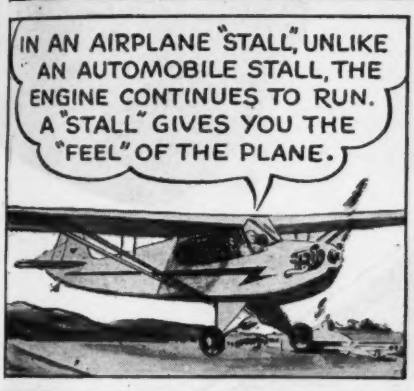
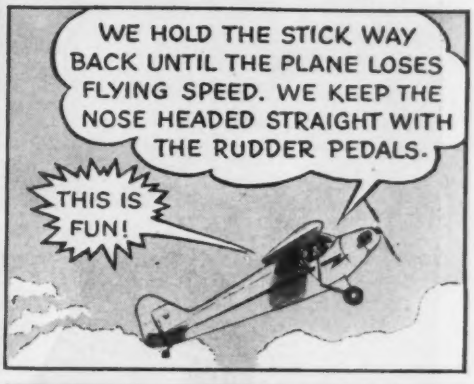
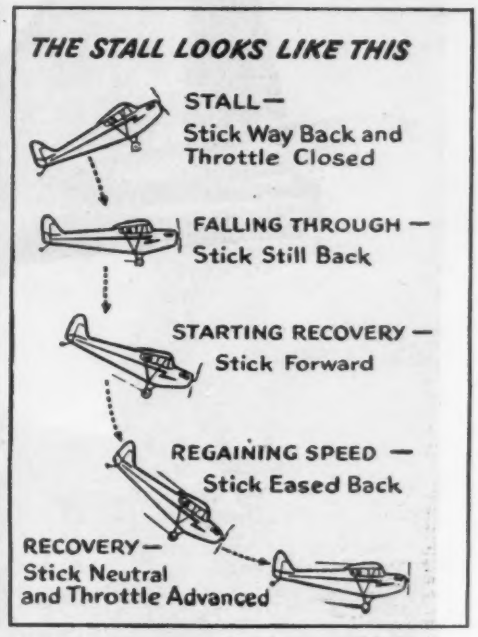



WE HOLD THE STICK WAY BACK UNTIL THE PLANE LOSES FLYING SPEED. WE KEEP THE NOSE HEADED STRAIGHT WITH THE RUDDER PEDALS.
THIS IS FUN!


THE STALL LOOKS LIKE THIS
STALL— Stick Way Back and Throttle Closed
FALLING THROUGH — Stick Still Back
STARTING RECOVERY — Stick Forward
REGAINING SPEED — Stick Eased Back
RECOVERY— Stick Neutral and Throttle Advanced

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3. Will peacetime Piper Cubs be sold on the installment plan?

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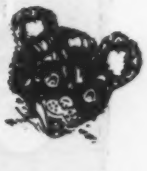

Points the Way to Wings for ALL Americans

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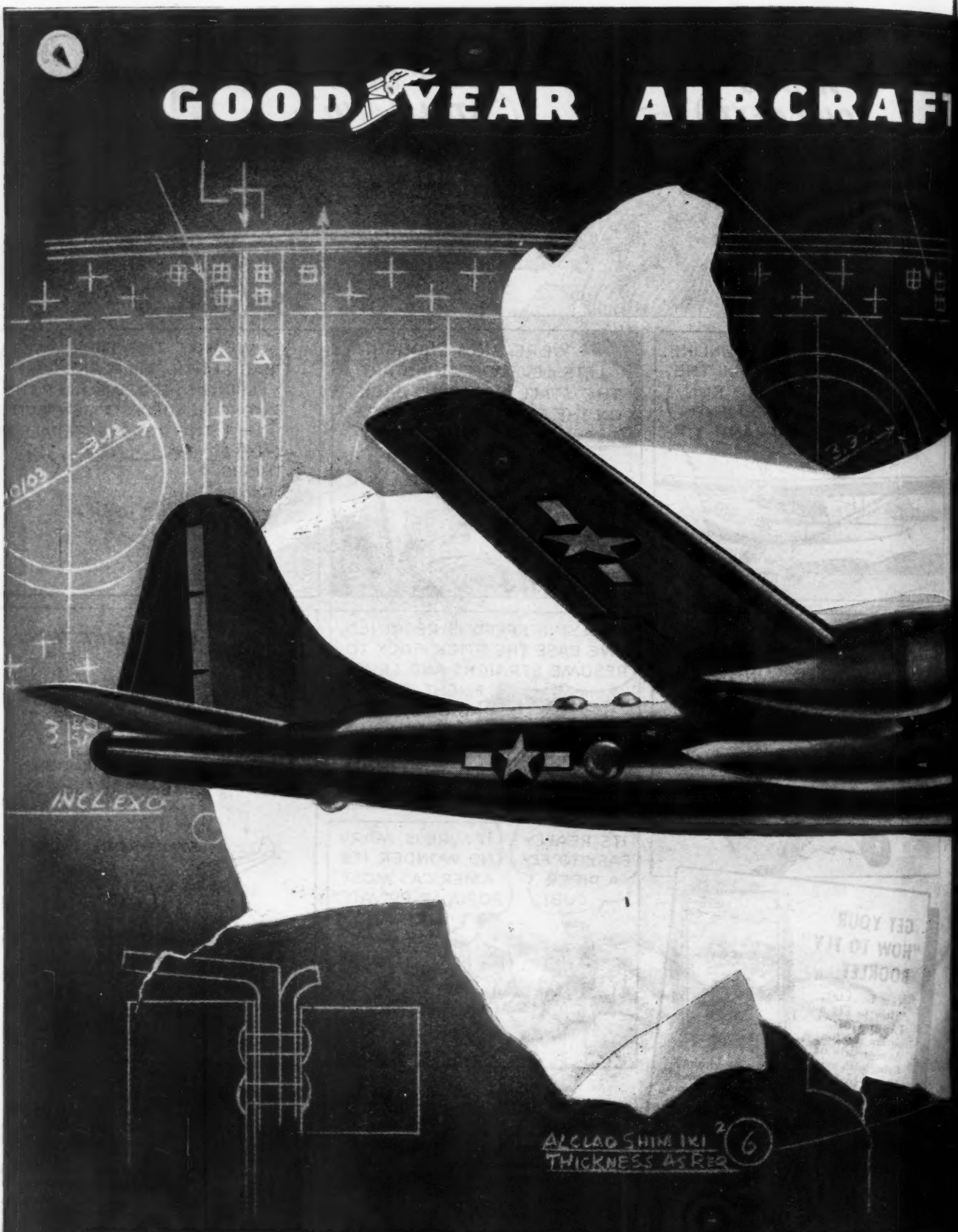

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE

1. By constructing major components to manufacturers' specifications.

2. By designing parts for all types of airplanes.

3. By re-engineering parts for quantity production.

4. By building complete airplanes and airships.

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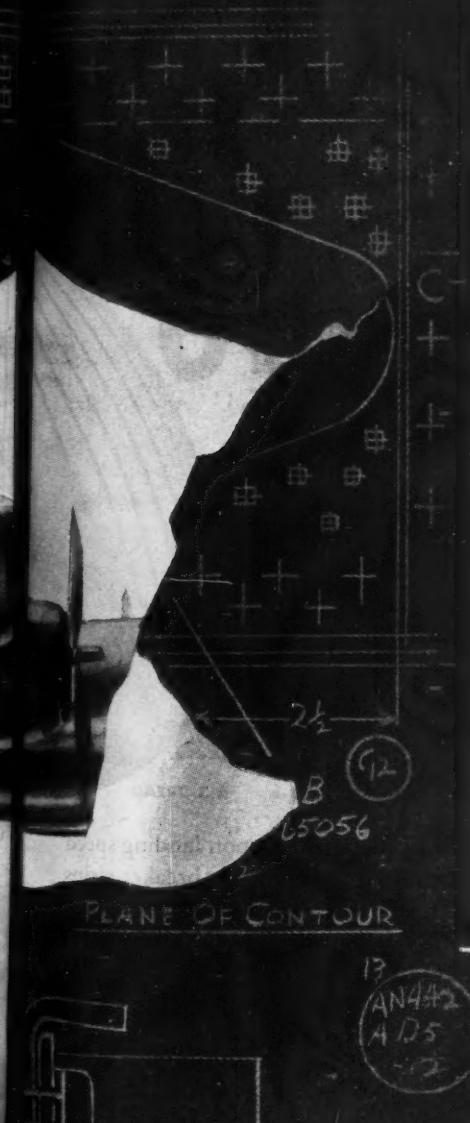

CONTRACT: W33-038-AC109

BOEING B-29 (Superfortress)

750 SETS: FORE AND AFT BOMB BAY SECTIONS, WING CAP SECTIONS, EMPENNAGES

INITIAL CONTRACT RECEIVED: *AUGUST 1943*

FIRST PRODUCTION UNIT DELIVERED: *MARCH 1944*

100TH PRODUCTION UNIT DELIVERED: *NOVEMBER 1944*

REMARKS: Conversion to B-29 production was effected without interrupting completion of B-26 contract in same plant. Although change-over involved building more than 8,500 tools and schooling of hundreds of employes in B-29 processing, first units were delivered full month ahead of schedule. Orders for 30 modifications in original design led to Goodyear's development of "quick-fix" method of making these changes without stopping production line--an achievement that is speeding deliveries of these essential components.

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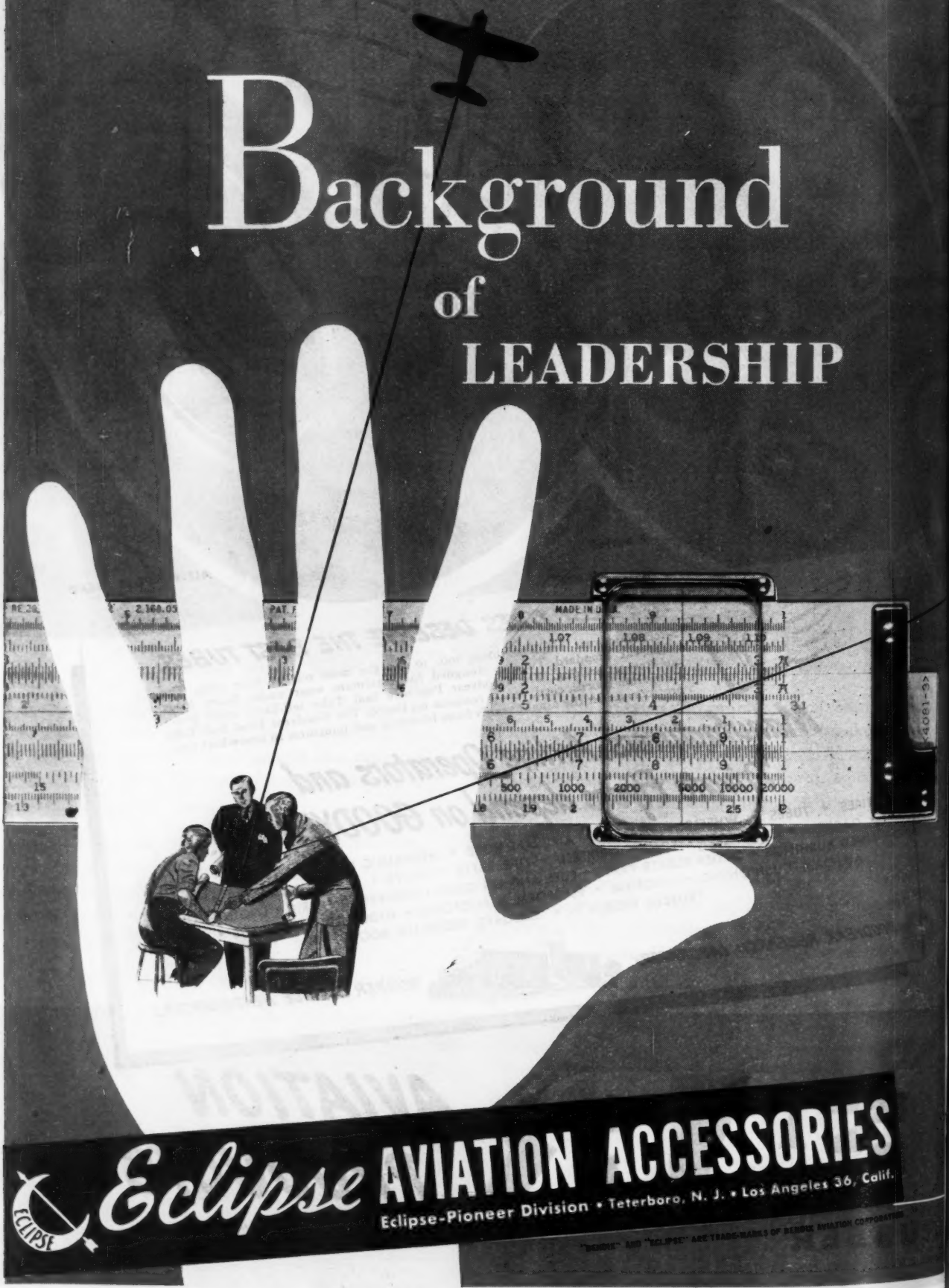

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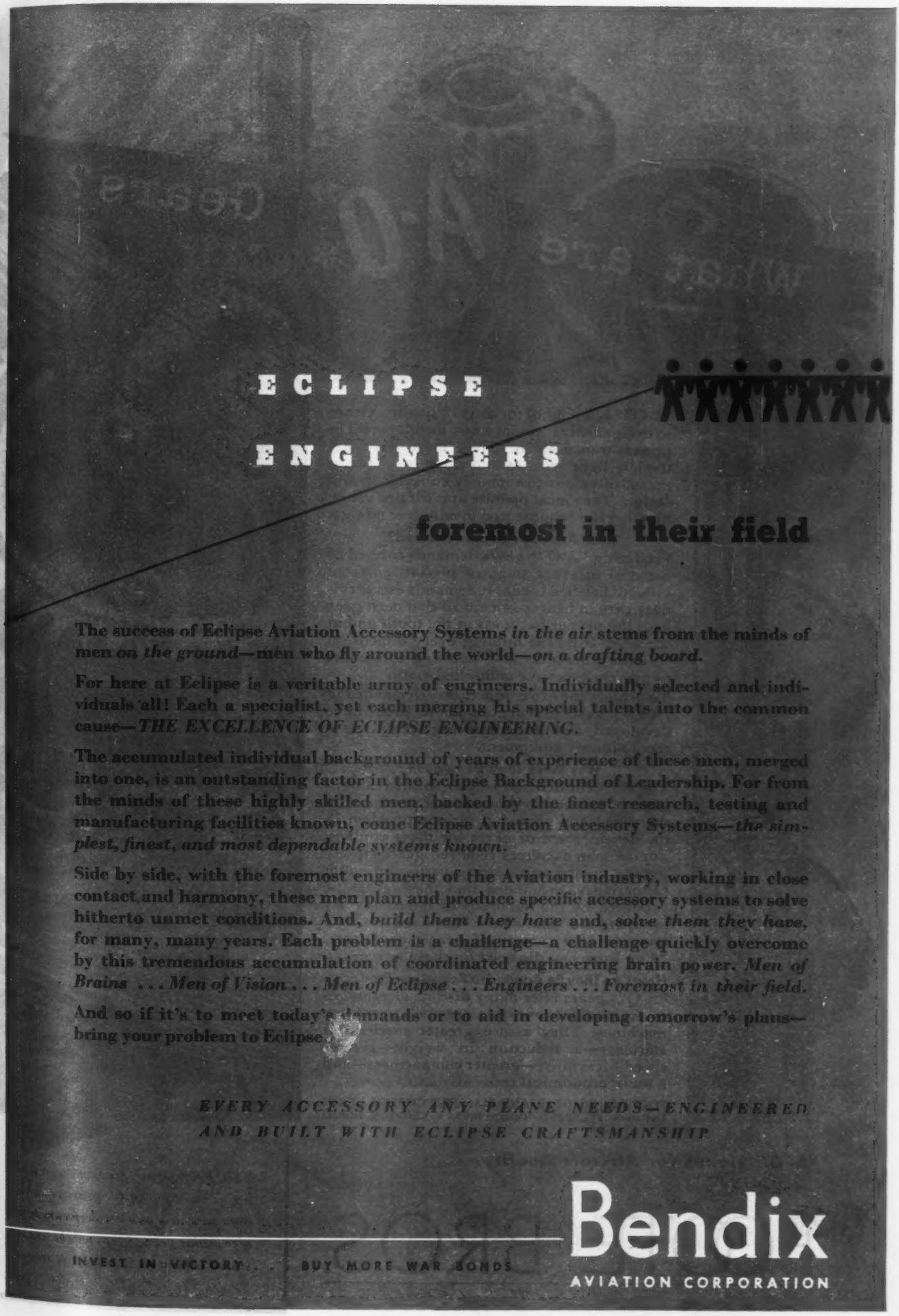
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Bendix
AVIATION CORPORATION

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FOOTE BROS. GEAR AND MACHINE CORPORATION
Department G, 5225 S. Western Blvd. • Chicago 9, Illinois

*"A-Q" Stands for Aircraft Quality

FOOTE BROS.

Better Power Transmission Through Better Gears

This informative product engineering manual on "A-Q" gears contains data on a new and revolutionary type of precision gear. A copy will be sent to you on request as soon as it is ready.

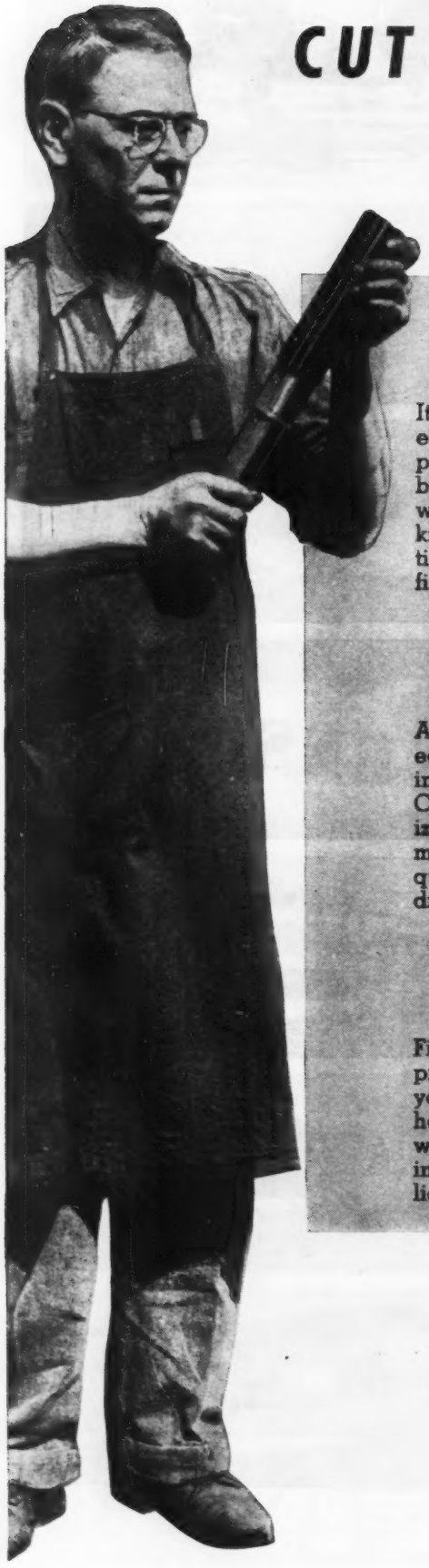
for Victory!

FLOAT PLANES THAT SERVE THE UNITED NATIONS

EDO AIRCRAFT CORPORATION, 402 SECOND STREET, COLLEGE POINT, N. Y., U.S.A.

Here's your 3-step plan for

BETTER TOOLS TO CUT PRODUCTION COSTS!



Use this sure way to knock the props from under production costs. Let Carpenter help you put this three-step plan to work in your tool room and heat treating department. With it you can reduce machine down-time and actually lower unit costs.

1. Cut The Cost Of Tooling-Up And Reduce Machine Shut-Downs!

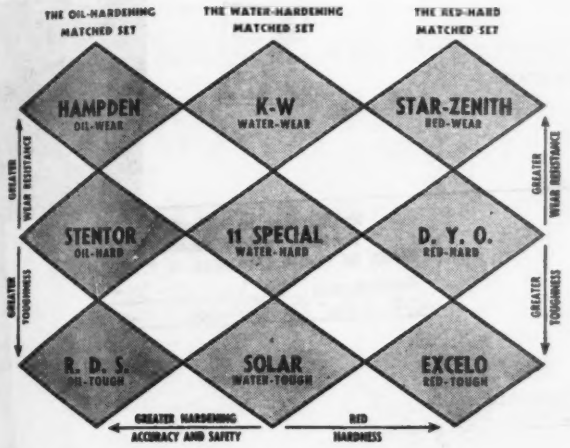
It's no trick at all to make sure of selecting the proper tool steel for each job when you use the Carpenter Matched Set Method. Many plants use this method of selection to lick production problems caused by premature tool and die failure. And it works! Now tool makers who have used it are relying on it to get *every* job done right. They know it cuts the cost of tooling-up and reduces machine shut-down time. And those savings are bound to show up in the cost of the finished product.

2. Insurance That Each Tool Will Pay-Off On The Job!

As you know, proper heat treatment is the second step to seeing that each tool is made to do its job right. And the Carpenter Heat Treating Guide quickly gives you this important information about each Carpenter Matched Tool Steel: Type analysis, Forging heat, Normalizing heat, Annealing treatment, Hardening treatment and Recommended drawing range. And this slide chart gives you tips on quenching, oxidizing atmospheres, heating time and heating speed for drawing. For your free copy, drop us a note on your company letterhead.

3. Check On Tool Life And Output Per Grind!

Find out which tools and dies need too frequent regrinding or fail prematurely in service. Carpenter Matched Tool Steels can help you lick this condition, and reduce unit costs. And for personal help in your tool room or heat treating department, get in touch with your nearby Carpenter representative. He knows tool steel inside-out, and can often provide the kind of engineering help that licks tough production bugs.



How The Carpenter Matched Set Method Helps To Solve Your Tool Steel Problems

These are really Matched Tool Steels, as one picks up its job where the other "leaves off."

The key steel is the one in the center, *No. 11 Special,* a straight carbon, tough timbre, water-hardening tool steel. When you have a tool to make, you first find out if it can be made from *No. 11 Special.* If the answer is "Yes", you go no further. But when the answer is "No", you use the diagram to point the way to the tool steel that will do the job. For greater *wear resistance,* you go north. For greater *hardening accuracy* and *safety,* you move west. Just follow the diagram.

To learn more about the ways this method can be used in solving *your* special problems, ask for a copy of the 167-page Carpenter Matched Tool Steel Manual. It contains an 80-page tool index and steel selector that many tool engineers find extremely handy. For your copy, write us a note on your company letterhead, indicating your title. (Free to tool steel users in U. S. A.)

RESULTS that show how the Carpenter Matched Set Method can boost plant output and cut costs all along the line:

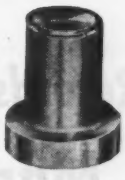
A STAKING PUNCH

only lasted about 40 hours until this method pointed the way to the proper Carpenter Matched Tool Steel for the job. With No. 11 Special, punch life jumped from 40 hours to over 6 months of service.

A SHAVING DIE

failed after 99,600 pieces were produced as it wore too rapidly. Then this method indicated Hampden for maximum wear resistance and hardening accuracy. Production per die jumped over 500%!

COINING PUNCHES

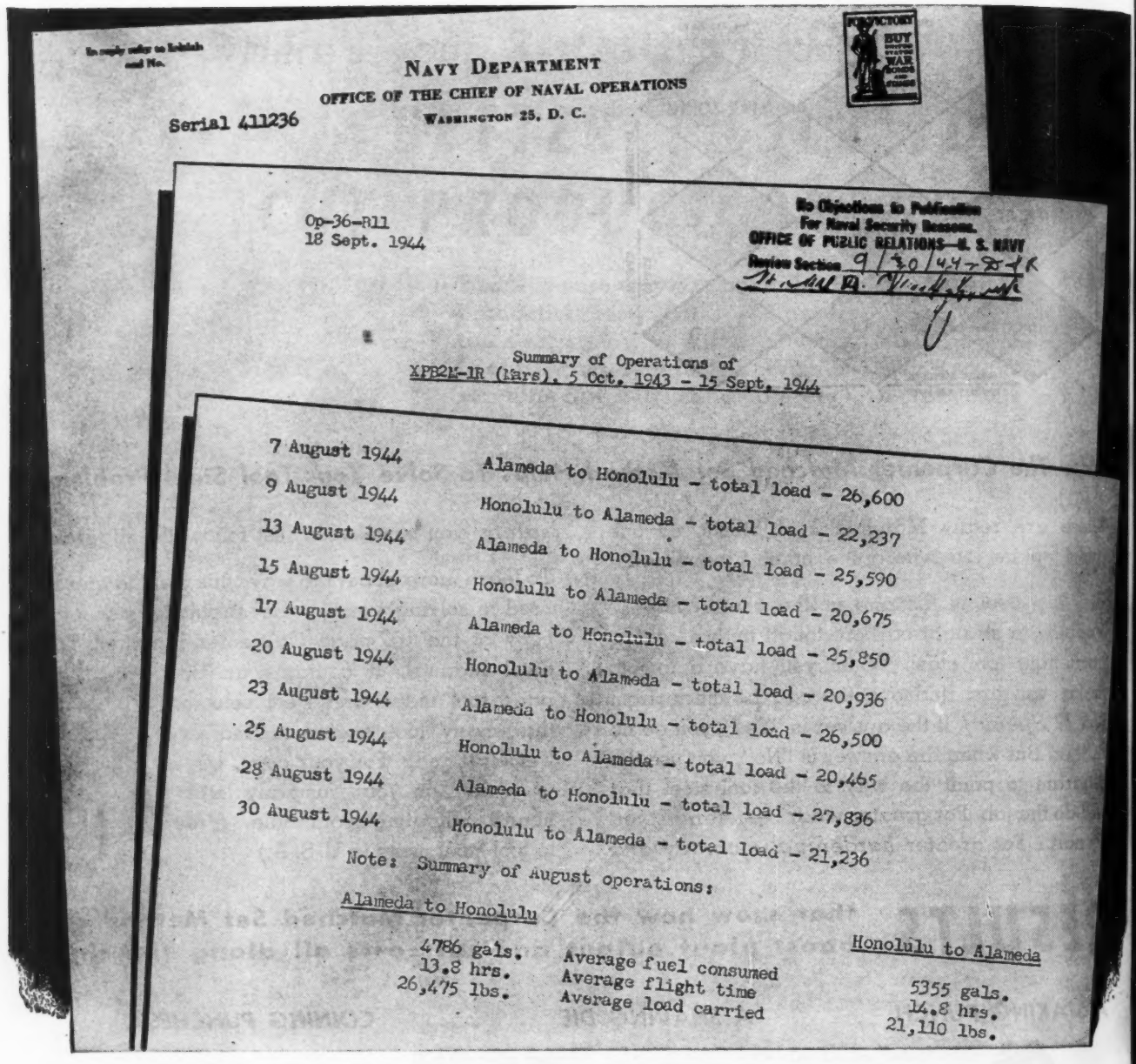


for forming bearing races from 1015 steel failed after running a half-day. The Diagram pointed to the greater toughness of Solar. Result: 250% more production per punch—and 48 fewer tools to make each month.

THE CARPENTER STEEL COMPANY • 128 W. BERN STREET • READING, PA.

Carpenter MATCHED TOOL STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, Louis, Indianapolis, New York, Philadelphia



In reply refer to Initials and No.

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Op-36-R11
18 Sept. 1944

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Review Section 9/30/44-DJK

Summary of Operations of
XPB2M-1R (Mars), 5 Oct. 1943 - 15 Sept. 1944

7 August 1944	Alameda to Honolulu - total load - 26,600
9 August 1944	Honolulu to Alameda - total load - 22,237
13 August 1944	Alameda to Honolulu - total load - 25,590
15 August 1944	Honolulu to Alameda - total load - 20,675
17 August 1944	Alameda to Honolulu - total load - 25,850
20 August 1944	Honolulu to Alameda - total load - 20,936
23 August 1944	Alameda to Honolulu - total load - 26,500
25 August 1944	Honolulu to Alameda - total load - 20,465
28 August 1944	Alameda to Honolulu - total load - 27,836
30 August 1944	Honolulu to Alameda - total load - 21,236

Note: Summary of August operations:

Alameda to Honolulu		Honolulu to Alameda
4786 gals.	Average fuel consumed	5355 gals.
13.8 hrs.	Average flight time	14.8 hrs.
26,475 lbs.	Average load carried	21,110 lbs.

Official Navy Records Show . . .

The Martin Mars Means Ease of Maintenance!

TAKE a look at the above Navy release and you'll see why we say the Martin Mars means ease of maintenance. Only one page of the release is shown, detailing operations for August 1944. Between the 7th and the 30th of that month the Mars made 10 trips between Hawaii and the Mainland. Since then she has steadily stepped up performance and in November completed 14 flights between Hawaii and California, flying a total of 33,600 miles and carrying more than 300,000 pounds of cargo. Her current utilization is 9.7 hours per day.

This high availability of Mars flying boats will pay substantial dividends to postwar airline operators. Less time for overhaul means more time in profitable operation. This savings, along with unusually low ton-mile costs and the fact that war's end will find Mars assembly lines tooled and manned for postwar delivery at a minimum purchase price, all combine to make the most economical overocean aircraft yet built. Companies interested in detailed performance data on the Mars, write

THE GLENN L. MARTIN COMPANY
BALTIMORE 3, MD.

Martin
AIRCRAFT
Builders of Dependable Aircraft Since 1909

Socony-Vacuum Announces

GREAT NEW TRANSPARENT CUTTING OILS!

ANTICIPATING current needs, Socony-Vacuum has developed, and is now announcing, a great new line of light-colored, transparent, odorless cutting oils.

These oils, the New S/V Sultrans, have already proved their superiority in exhaustive field tests, and are now in service.

In addition to better visibility of the work, and no odor to cling to operators' clothing, the new oils also provide: outstanding lubricity; less sensitivity to changes in the hardness and structure of metals; improved drainability; and better all-around performance for longer tool life and improved finish.

All of these improvements have been added without sacrificing anti-weld and pressure resistance characteristics. The New S/V Sultrans are available now for your cutting operations. Ask your Socony-Vacuum representative for details.

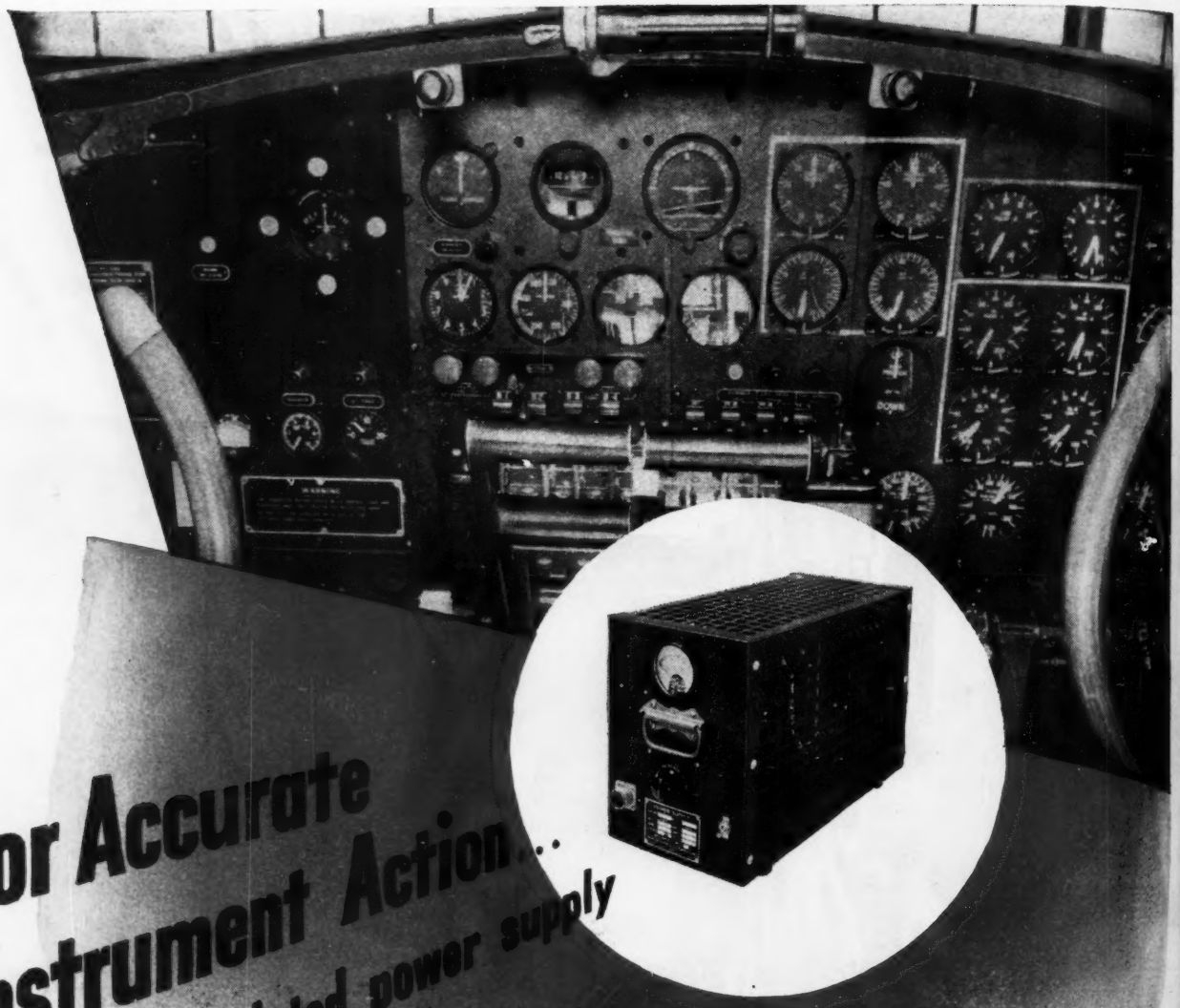
SOCONY-VACUUM OIL CO., INC.
Standard Oil of N. Y. Div. · White Star Div. · Lubrite Div. · Chicago Div. · White Eagle Div. · Wadhams Div. · Magnolia Petroleum Co. · General Petroleum Corporation of California.

CALL IN SOCONY-VACUUM FOR "CORRECT LUBRICATION"

GARGOYLE Lubricants

Socony-Vacuum's FIVE STEPS to Lower Production Costs for You

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured



For Accurate Instrument Action . . . Federal's regulated power supply

Reliable aerial navigation depends upon absolute accuracy of aircraft instruments.

Constant testing of these instruments under flight conditions . . . in the air or on the ground . . . is possible with Federal's regulated-voltage power supply.

Designed to replace unwieldy storage batteries normally used for this purpose, this light-weight Federal power supply converts 115-volt alternating current into a closely-regulated, filtered direct current for the accurate testing of electrical instruments and other aircraft accessories.

This is only one of the many types of all-purpose power supply units powered by Federal Selenium Rectifiers . . . another example of Federal design and manufacturing leadership . . . and another good reason why you should *consult Federal first.*

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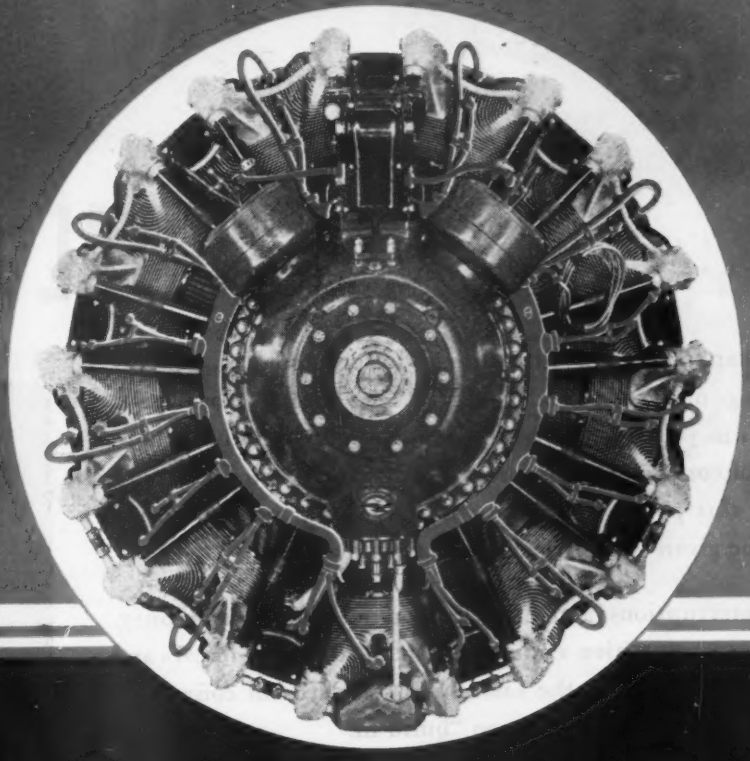
Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

BOLTON ENGINEERING

The Answer to a Challenge from "SIDE-LINE" Enemies!



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Geared to the Grind of Modern Combat

BOLTON MANUFACTURING CORP., WEST HAVEN, CONN.

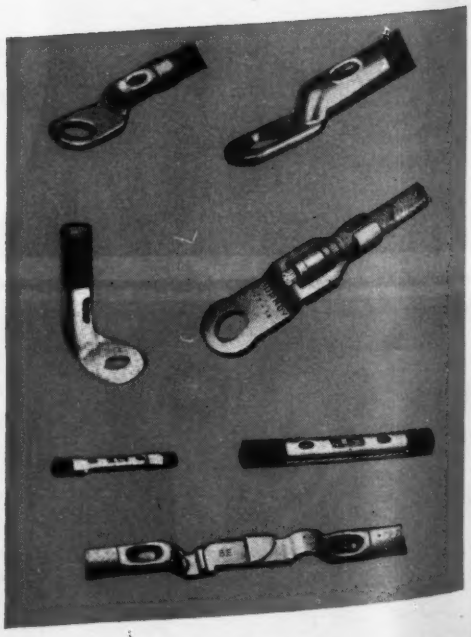
OF VITAL CONNECTORS!

It's human to take the "little things" for granted. Yet, a goodly percentage of the electrical troubles . . . in your plant, or in your products in your customer's plant . . . are due to nothing more than poor connections. *Check with your maintenance or service men on this point.* Then you will agree that more attention should be given to electrical connections.

Plant interruptions and electrical outages cost real money. And when competition again gangs up on you, your dealers and customers will expect the same high standards in connectors as in the other components you "build in."

Yes, electrical connectors *are* important . . . sufficiently so that you should insist that the connectors you use remain efficient, and trouble-free, in service. The kind that go on *quick,* and stay on fast; that withstand corrosion, temperatures, vibration, or shock. The kind that are available . . . in all sizes and for all purposes . . . here at Burndy. Let us send you our latest catalog.

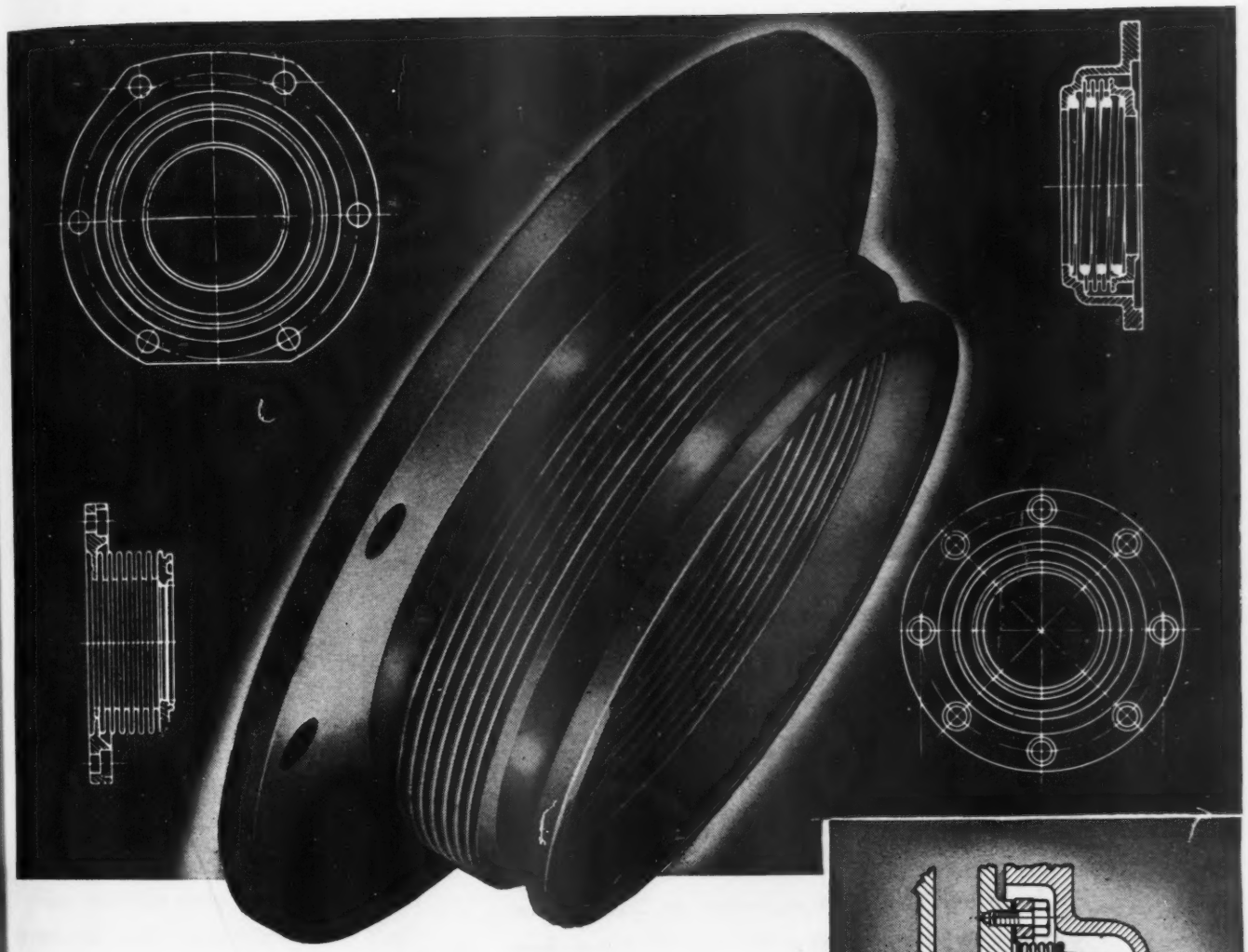
Burndy Engineering Co., 107A Bruckner Blvd., New York 54, N. Y.



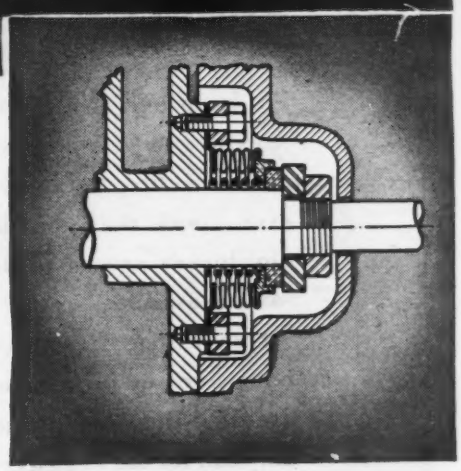
Headquarters for CONNECTORS

Burndy

In Canada:
Canadian Line Materials, Limited, Toronto 13



Now the WHOLE doughnut goes to work



WHEREVER there's danger of leakage of gas or liquid around a rotating shaft, there's need for a Sylphon Shaft Seal. Principles successfully applied to control problems for more than 40 years, have proved eye openers in this special field.

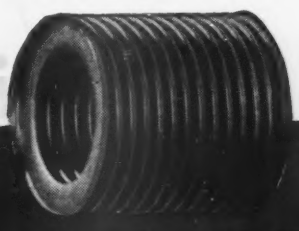
Basically, the application is very simple; a sturdy helical spring holds circular ring or *seal nose* firmly against a *sealing surface* mounted at the end of a shaft. A Sylphon Bellows provides a flexible, gas- and liquid-tight connection between a *mounting flange* and the *seal nose*.

Sylphon Shaft Seals are engineered for each specific application. Sizes range from seals for tiny instrument shafts to seals for huge military installations. Finely machined and balanced, they afford a perfect seal against pressures up to hundreds of pounds, operate at shaft speeds up to 400 RPM.

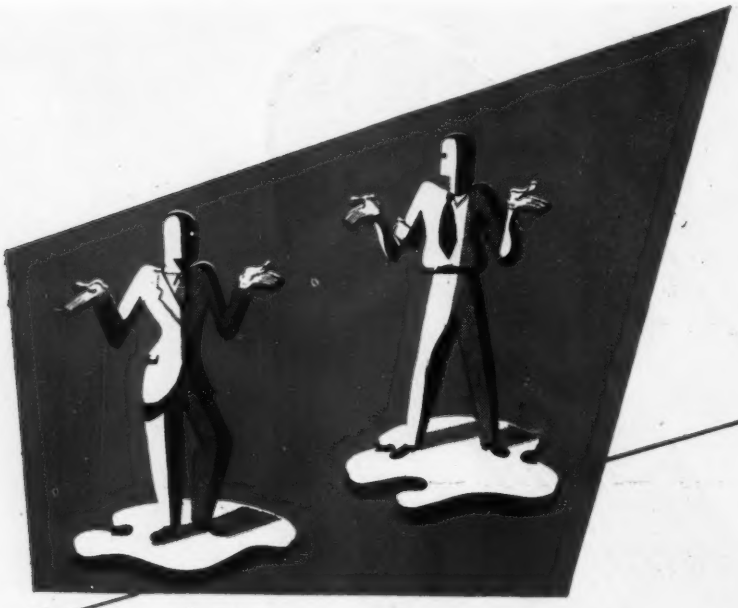
Sylphon Shaft Seal. Prevents leakage around a rotating shaft where the shaft extends from inside to the outside of enclosure.

New Movie—"The Story of Metal Bellows" is available to interested executives and organizations.

Write for Bulletin CA-825, giving as much specific information as possible about your problem.



FULTON SYLPHON



Our engineers don't understand each other

We keep our engineers separated by 2500 miles. And for good reason. One group consists of hot shots on hydraulics, the other on electronics. They don't even speak the same language. Several thousand employees are separated for approximately the same reason.

Our brilliant executives, however, can talk out of both sides of their mouths... Electronics *and* Hydraulics. But when the going gets tough, they invariably call for our engineers; because the stuff we make is so precise and technical nobody but electronic or hydraulic engineers can actually understand it.

Your engineers and ours should get together. They'd talk the same language. And our factories can translate their conversation into what you want.

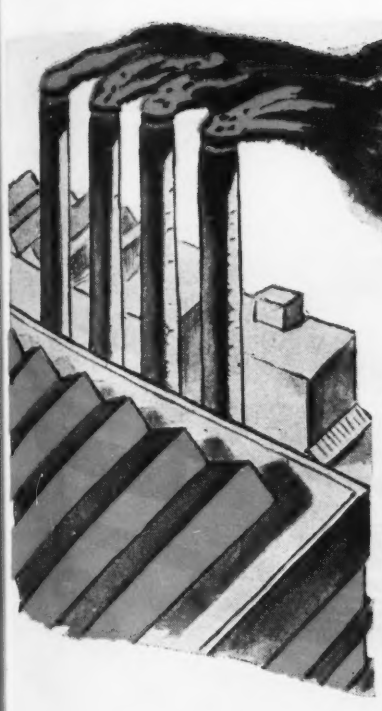
Aireon

MANUFACTURING CORPORATION

Formerly *AIRCRAFT ACCESSORIES CORPORATION*

Radio and Electronics • Engineered Power Controls

NEW YORK • • CHICAGO • • KANSAS CITY • • BURBANK



DON'T LET PRE-WAR METHODS KILL POST-WAR PROSPERITY!

The war years have proven to American Industry that the light machine tool has an important place in Production. Walker-Turner machine tools have demonstrated their ruggedness under most exacting conditions.

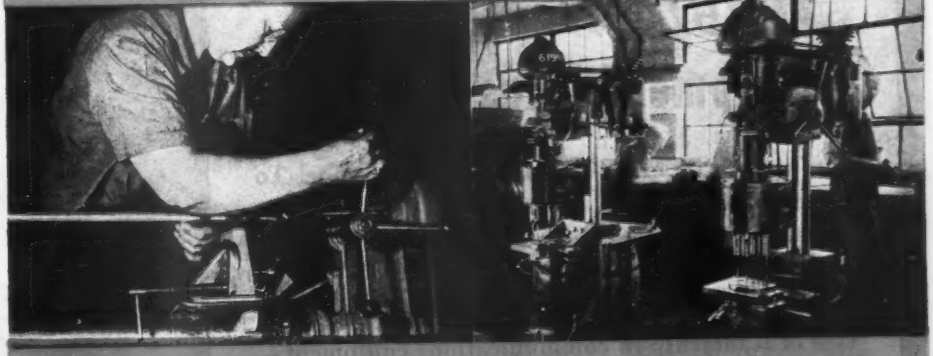
Don't let pre-war operating methods affect your post-war competitive position. The versatility of Walker-Turner machine tools will ensure production equal to—and, in many cases, better than—heavier and more expensive equipment.

WALKER-TURNER COMPANY, Inc.
Plainfield **New Jersey**

HERE'S HOW WALKER-TURNER MACHINE-TOOLS CUT COSTS!

260-5200 R.P.M. 60-5300 S.F.M. 160-8300 R.P.M.

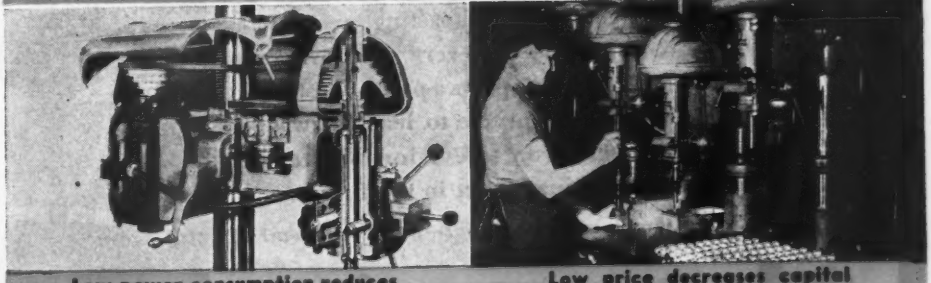
Wide range of operating speeds enables you to select the optimum cutting speed for any material.



Walker-Turner flexibility saves time and cuts costs in special tooling set-ups.

Set up horizontally, this Walker-Turner 15" Drill Press flares the ends of tubing.

This Walker-Turner 20" Drill Press drills five holes and reams two holes in one operation.



Low power consumption reduces operating costs.

This motor on a Walker-Turner 20" Drill Press provides speeds for drilling up to ¾" in steel, 1" in cast iron.

Low price decreases capital investment.

This Walker-Turner 4-spindle 20" Drill Press costs no more than a single heavy unit, yet has several times its production capacity.

walker-Turner COMPANY, INC. PLAINFIELD, N.J. U.S.A.

MACHINE TOOLS

DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS

In meeting the challenge of the future, *Western Electric* equipment leads the way

War's end will bring a challenge to everyone. To those identified with communications and transportation, faster, better interchange of ideas and goods will be the order of the day.

We at Western Electric—with our 75-years heritage of leadership in communications equipment—believe we are peculiarly qualified to accept this challenge.

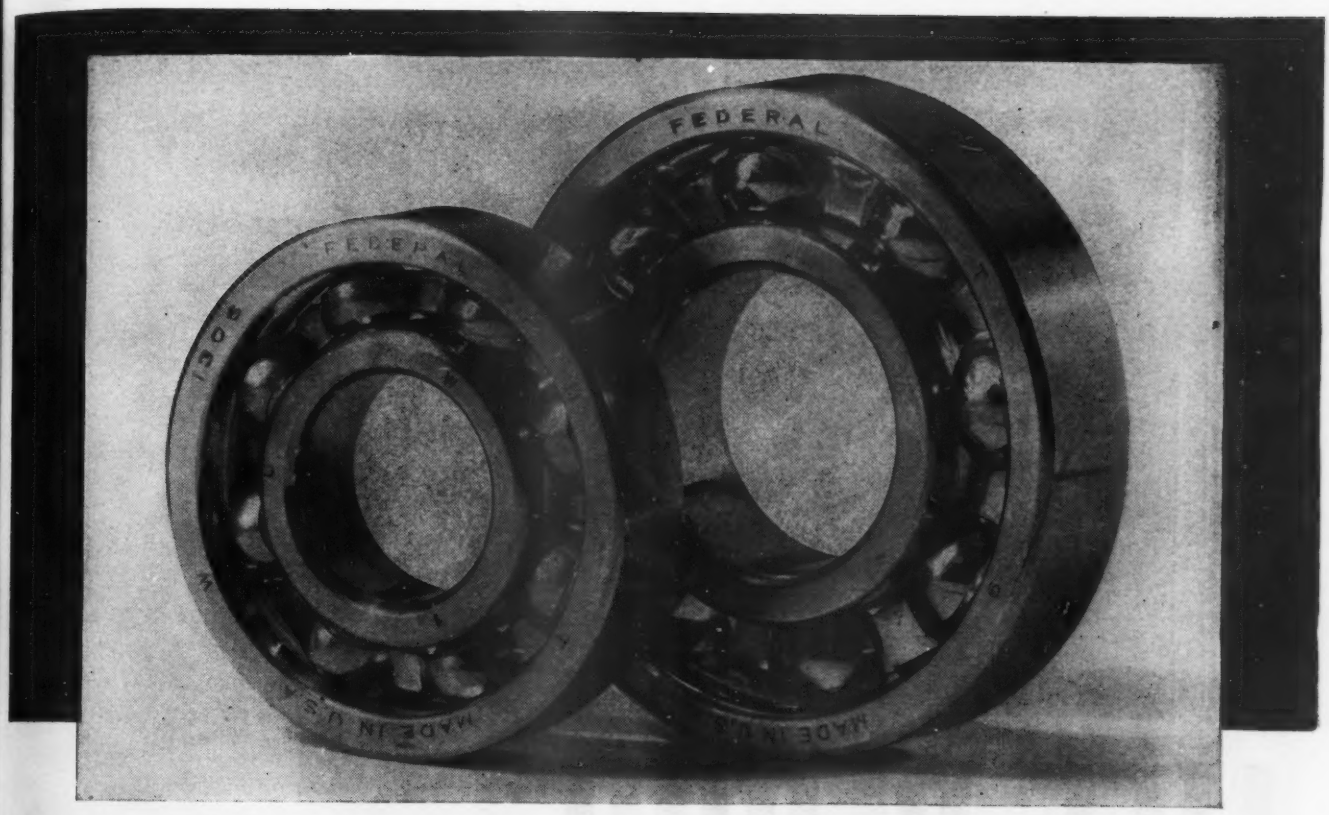
In world-wide telephony, broadcasting, aviation, marine and mobile radio—in every field where sound-transmission apparatus plays a part—Western Electric has led and will continue to lead the way. In these fields as well as in television, Western Electric will play a dominant part in the future.

To speed Victory, buy more War Bonds—and keep them!

Western Electric

ARSENAL OF COMMUNICATIONS EQUIPMENT

Distributed by GraybaR ELECTRIC COMPANY



Speed up Reconversion with

FEDERAL

BALL BEARINGS

INDUSTRIAL • AUTOMOTIVE

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THE FEDERAL BEARINGS CO., INC.

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LIFE BLOOD
for Aircraft Controls

Several important types of Whiz Hydraulic Fluids are manufactured by R. M. Hollingshead Corporation, a major supplier for Army and Navy aircraft. Of these fluids, two types are currently in great demand. Both conform fully to Government specifications and each is supplied in two grades.

★

Your inquiries about these hydraulic fluids will receive prompt attention. Our engineers will gladly work directly with yours in designing special chemical products to meet unusual requirements. ***R. M. Hollingshead Corporation, Camden, N. J.; Toronto, Canada.***

TYPE AND GRADES	TYPE AND GRADES
Whiz Castor Oil Base Type Grade C—Light Grade A—Heavy	Whiz Petroleum Base Type Grade L—Light Grade M—Medium
INDICATED USES Used primarily in hydraulic braking systems, shock absorbers, strut shocks, retractable landing gears. Other mechanisms where specified.	**INDICATED USES** For use in automatic pilots. Other mechanisms where specified.
CHARACTERISTICS Non-gumming; provides maximum lubrication and correct viscosity. Maintains stable fluidity. Grade C for sub-zero temperatures. Grade A for warmer climates.	**CHARACTERISTICS** Non-gumming. Non-corrosive—will not damage metal or synthetic rubber parts. Maintains stable fluidity. Grade L for temperatures down to 60° F. will not thicken, congeal, or freeze. Grade M designed for use at temperatures of 50° F. and higher.

Hollingshead

LEADER IN MAINTENANCE PRODUCTS

Whiz

Also makers of Whiz Rust Preventive Compounds, Compounded Lubricants, Lubricating Oils, and Cleaning Compounds for Aircraft.

BUY MORE BONDS!

PLANNED INSTALLATIONS LIKE THIS

MAKE FASTER, FINER FINISHING A CERTAINTY

Completely Coordinated FINISHING SYSTEMS Engineered to Your Plant and Product

Here is a typical example of what proper planning can accomplish in coordinating the various processes of Finishing into a compact, smoothly-operating system that conserves both time and manpower — and does a better job. This installation was specifically designed to handle the complete finishing of aircraft engine parts. But—whatever the product to be processed—regardless of nature, size or shape—Mahon engineers can be of material assistance in planning and producing the precise equipment *you* may need to put YOUR production on a fast-moving, highly efficient and economical basis.

Designers and Manufacturers of Metal Cleaning Machines, Rust Proofing Machines, Hydro-Filter Spray Booths, Ovens of All Types, Filtered Air Supply Systems, Hydro-Foam Dust Collectors — and Many Other Units of Special Production Equipment — Including Complete Finishing Systems.

THE R. C. MAHON COMPANY

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Marquette Aircraft Wipers
are in Use All Over the World

DURING these years we have gained invaluable experience. We have provided hydraulic and electric windshield wipers and bombardier wipers for the aircraft of our Air Forces. They have proven successful at high speeds... under severe and variable climatic conditions ... on curved and flat glasses of many shapes and sizes. Marquette wipers are universally accepted as important factors in safe flying.

ARMY E NAVY
FOR EXCELLENCE

The Marquette METAL PRODUCTS CO.
CLEVELAND 10, OHIO

Manufacturers of: HYDRAULIC AND ELECTRIC WINDSHIELD WIPERS FOR AIRCRAFT
HYDRAULIC GOVERNORS FOR DIESEL ENGINES • ROLLER BEARING TEXTILE SPINDLES • FUEL OIL PUMPS
AIR COMPRESSORS • PRECISION PARTS AND ASSEMBLIES

Uniform, Synchronous Speed at Every Station

Teletype Machine powered with a Holtzer-Cabot motor

Electric motors driving the intricate mechanisms of machines that transmit and record messages verbatim must have identical operating characteristics at every station. Since standard "off-the-shelf" motors cannot meet the strict performance requirements, such as uniform, synchronous speed, quietness, load cycles, etc., the solution is a special motor designed to exactly meet the particular operating conditions.

For over 50 years Holtzer-Cabot has designed and built special motors to fit the application. Many machines such as teletype machines, and other sending and receiving equipment are Holtzer-Cabot powered.

Although, today, all of our plant facilities are being utilized for building special fractional H.P. motors for military use, our motor development engineers will gladly discuss your post-war motor requirements with you. No obligation of course.

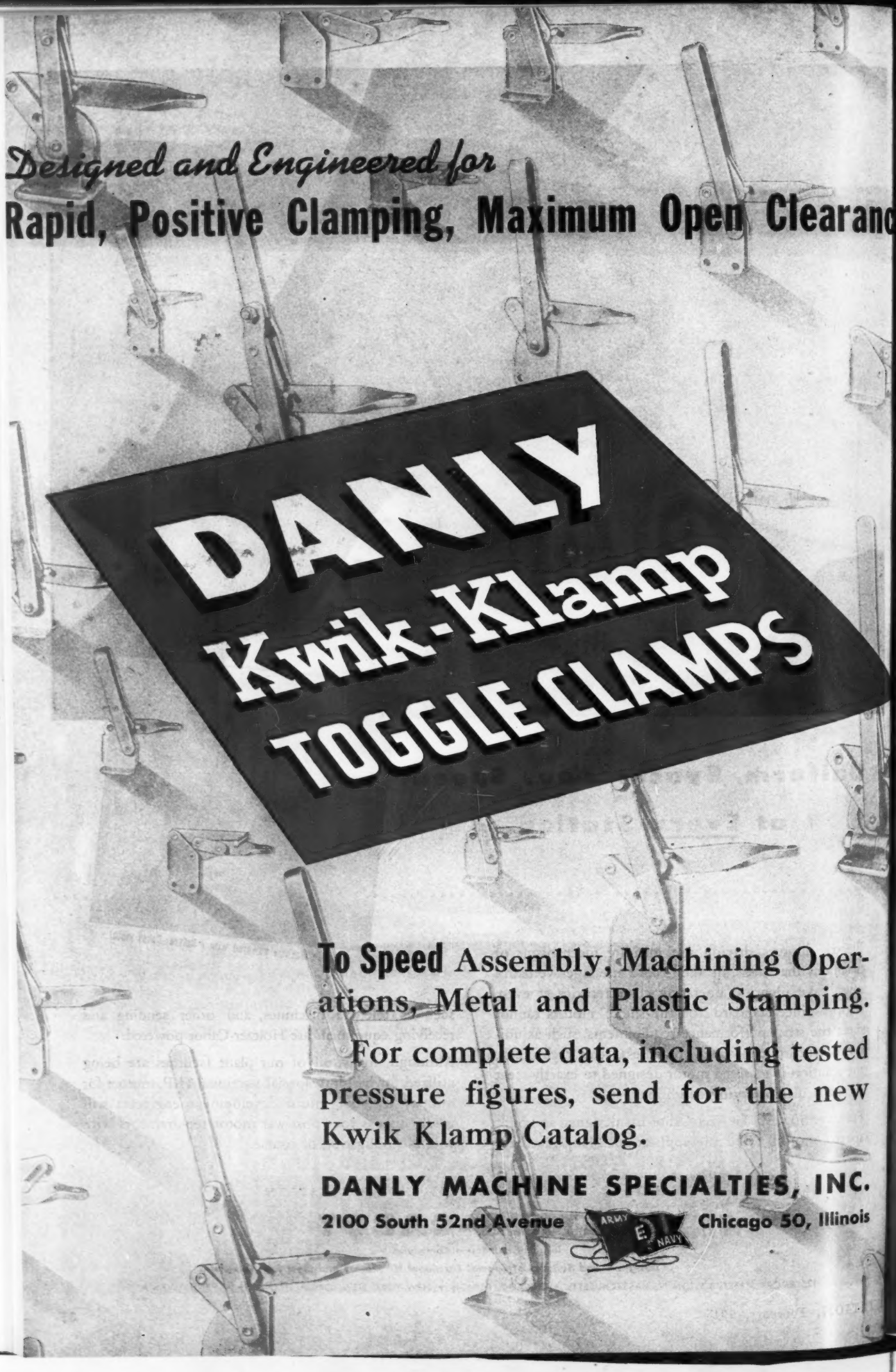
SPECIAL MOTORS DESIGNED TO FIT THE APPLICATION

HOLTZER-CABOT

Division First Industrial Corporation

Designers and Builders of Special Fractional HP Motors and Electrical Apparatus

125 AMORY STREET, BOSTON 19, MASSACHUSETTS • CHICAGO, ILLINOIS • NEW YORK, NEW YORK • PHILADELPHIA, PENNSYLVANIA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Rapid, Positive Clamping, Maximum Open Clearanc
DANLY
Kwik-Klamp
TOGGLE CLAMPS
To Speed Assembly, Machining Operations, Metal and Plastic Stamping.
For complete data, including tested pressure figures, send for the new Kwik Klamp Catalog.
DANLY MACHINE SPECIALTIES, INC.
2100 South 52nd Avenue
ARMY E NAVY
Chicago 50, Illinois

A quiet advertisement for a noise-weary World

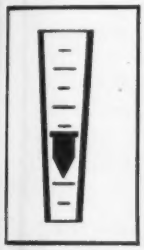
—the Rotameter and its advantages to you for flow rate measurement and control

ROTAMETERS

With all the noise in the World today, perhaps you will appreciate advertisements of a more quiet sort. So we are taking this simple way of telling you about our product.

We make rotameters for flow rate measurement and control, and we believe it is important that you know about them because they offer advantages which you cannot obtain in any other flow rate measuring device. First, let us describe the principle of the rotameter.

The Principle of the Rotameter



The rotameter is an "area-type" meter in which the variation in area is obtained by means of a vertical ***tapered*** tube with the smallest diameter at the bottom. A weight of fixed diameter (called the "float") moves freely within this tapered tube and hence the area between the float and tube ***increases*** as the float rises. This area then becomes a measure of the flow and for every flow rate there is a fixed position of the float in the tube. Therefore, the rotameter can be accurately calibrated to read directly in flow rate. This method of flow measurement gives advantages of great importance.

The Advantages of the Rotameter

Succinctly stated, the main advantages of our rotameter are as follows:

(1) Since the metering tube is usually transparent, the main metering elements (float and tube) and the fluid being metered are ***clearly visible.*** High accuracy may be maintained because dirt accumulations are immediately perceived and because a secondary remote reading instrument, when used, may be quickly checked against the primary metering element, the rotameter.

(2) A wide flow range may be obtained in one rotameter. A ratio of 20 to 1 from maximum to minimum flow is easily reached if necessary.

(3) Since area variation is measured (rather than head), the calibration curve of the rotameter is practically a straight line so that a direct reading scale with evenly spaced divisions is obtained. There is no compression of the divisions at low flows, so the same high metering accuracy is gained ***throughout the flow range.***

(4) Because the area between the float and tube increases when the flow rises, the pressure drop across the float is low and ***constant.*** Pumping costs are reduced and low initial head may be tolerated by using an oversize meter with a light float.

(5) Our patented Stabl-Vis rotameter compensates for normal variations in viscosity and density so that viscous oils and chemicals, such as concentrated sulphuric acid, may be measured accurately in spite of wide temperature changes.

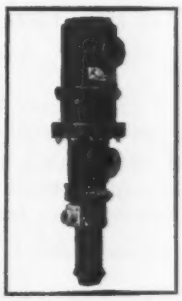
(6) The metering float travels a distance of at least 5 inches, and meters are obtainable with float travel as long as 24 inches. Hence, by shortening the flow range and lengthening the float travel, higher accuracies may be obtained with the rotameter than with any other flow rate measuring device.

(7) The float moves freely in the metering tube so there is no friction or hysteresis. Therefore, the rotameter reaches the Instrument Engineer's ideal goal of high accuracy, ***consistently maintained*** during years of service.

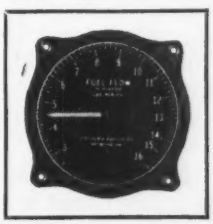
(8) Due to its simplicity, the rotameter is readily made corrosion proof and, therefore, may be used to measure flows of gases, liquids and slurries that no other meter will handle with continuous success.

(9) Also, due to its simplicity, the rotameter is easy to install and reasonable to maintain.

The Scope of Fischer & Porter Rotameters



We originated the precision-bore tapered rotameter tube of boro-silicate glass, and have designed and built a full line of rotameters to solve the varied flow rate problems of Industry. We can measure liquid flows from 0.15 cubic centimeters per minute up to 14,000 gallons per minute, and gaseous flows from 3 cubic centimeters per minute up to 16,000 cubic feet per minute. Temperatures to 750° F. and pressures to 10,000 p.s.i. can be provided for in our equipment. Flow indication, flow recording, flow totalization and automatic flow control are all available to you in designs which have been proved by many field installations to be practical, accurate and dividend-paying meters.



A steady stream of basic improvements in the rotameter have come from our research laboratories. A most recent worthwhile development has been a marked betterment in the electrical inductance-bridge method of telemetering the position of the rotameter float to a remote recording or controlling instrument. This method in the past has been somewhat discredited by Instrument Engineers because it was subject to errors from temperature and voltage variations, and because it lacked power. Because of the great simplicity of the inductance-bridge principle, we decided not to accept this dictum, so we went to work to overcome its weaknesses. Today we can guarantee that our new circuit is not affected by wide variations in either temperature or voltage, and furthermore it has ***three times*** the power of any previous comparable instrument, so that the pen now positions with speed, positiveness and accuracy.

One of our most important recent product announcements for aviation has been a remote-reading flight meter for gasoline or oil. This instrument has a new electric circuit that is free of friction and hysteresis. It is also the only flight meter that compensates for viscosity and density variations in the fluid being metered. It offers high accuracy in flow rate measurement for post-war planes.

How to obtain "A New Era in Flow Rate Measurement"

We have prepared an interesting bulletin entitled, "A New Era in Flow Rate Measurement," which expands the above material into a profusely illustrated, semi-humorous and instructive manual for those who have flow rate control problems and who would, therefore, like to know more about our rotameters. If you will write to us, we will gladly send you a free copy without any obligation. If, in the same letter, you can outline one of your most important flow rate problems, we'll tackle it gladly and try to come up with a good answer for you.

FISCHER & PORTER COMPANY
302 COUNTY LINE ROAD • HATBORO • PA.

Fischer & Porter Company has pioneered EVERY basic rotameter improvement!

The CONE AUTOMATIC MACHINE COMPANY

sees many

GOOD THINGS AHEAD

It is reported that . . . . . .

Through recent explorations our known reserves of bauxite (source of aluminum) have been increased by more than 100 million tons. *Science News Letter.*

get ready with CONE for tomorrow

The National Postwar Products Exposition is scheduled to open March first at the Chicago Coliseum. *Marcus W. Hinson, Ex. Mgr. 1513 S. Wabash Ave., Chicago 5.*

get ready with CONE for tomorrow

A new tractor-drawn farm implement plows, discs and harrows in one operation. *"Till-Master", Till-Master Mfg. Co., Portland, Oregon.*

get ready with CONE for tomorrow

Today's scientists have revived a four-thousand year old method of killing insect pests with fine dusts. These dusts adhere to the insect's skin or casing and interfere with its water balance. Death results from thirst. *Dr. H. V. A. Briscoe, Imperial College, London.*

get ready with CONE for tomorrow

A railroad now has one-hundred plywood box cars and one thousand on order. The weight saving is said to be about two tons per car. *Great Northern Railway.*

get ready with CONE for tomorrow

A new "de-barker" is being used in some pulp mills that removes the bark from logs by the force of a jet of water at 650 pounds pressure without removing any wood. The saving in wood is said to be as high as 20%. *Scientific American, Oct. 1944.*

get ready with CONE for tomorrow

The continuous injection molding of plastics is made possible by a new machine. *Chrysler Corp.*

get ready with CONE for tomorrow

A new electric iron requires no cord but absorbs heat from an electrically heated and thermostatically controlled base. *Eureka Vacuum Cleaner Co., Detroit.*

Jet propulsion may be used to power sailplanes and gliders and, in miniature, for flying models. *McGraw-Hill Overseas' Digest.*

get ready with CONE for tomorrow

A university engineer has announced the discovery of a new type of concrete, useful for building construction, that is stronger than steel and lighter than aluminum. *Northwestern University.*

get ready with CONE for tomorrow

A new $1,800, four-room house will come directly off the assembly line on to a truck for delivery. *"Wingfoot Homes", Goodyear Tire and Rubber Co.*

get ready with CONE for tomorrow

A "zipper" fastening has been developed that is claimed to seal in liquids and gases. *B. F. Goodrich Co.*

It has been stated that the weight of aircraft engines has been reduced about 40% since the beginning of the war. *Aircraft Yearbook 1944.*

get ready with CONE for tomorrow

Manufacturers of the "jeep" plan to sell it to farmers and are reported to have ordered 25,000 bodies for this purpose. *Willys Overland.*

get ready with CONE for tomorrow

A machine has been patented for making barrels out of cardboard for packing butter, flour, sugar, chemicals, fruits, or small parts. *Everett Industries, Akron.*

get ready with CONE for tomorrow

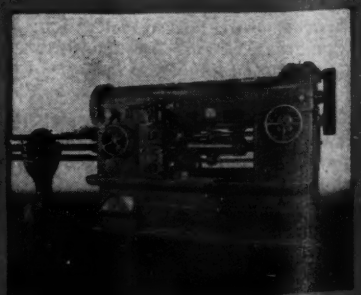
Aviation and electrical engineers are collaborating on an electric drive for aircraft. This will, if practical, permit the location of engines in the fuselage and do away with nacelles in the wings. *Hughes Aircraft Co. and Westinghouse.*

get ready with CONE for tomorrow

One of the country's largest grocery chains is planning to ship fresh fruits and vegetables to its markets by airplane. *A & P.*

Here is performance that is definitely AHEAD

This part calls for extreme accuracy and yet requires wide forming cuts on a variety of diameters. In one position an attachment taps an inside thread 5/16"-18 while, at the same time, a die cuts an outside thread 5/8"-27. Produced on the 6 Spindle Conomatic at the rate of 12.5 seconds per part.



CONE

AUTOMATIC MACHINE CO., INC. ★ WINDSOR, VERMONT, U. S. A.

INACCESSIBLE

. . . Helicopters will change the language of Transportation

The term "inaccessible" will no longer apply to many remote locations—postwar. For the helicopter, operated by professional pilots, will provide swift, safe transportation and light cargo service to many points heretofore accessible only by packmule, portage and canoe.

To hack a trail by machete through dense trackless tropical jungle, may take months—even to points a hundred miles away. The same distance by mule over mountain trails might take a week or more. But with a helicopter, it would be only a matter of minutes . . . and any small clearing might serve as a landing field.

Such transportation is almost unrivaled in its economy—and as comfortable as it is swift and safe. Over dangerous and difficult areas—the steaming "Green Hell" of Matto Grosso, the dense jungles of the Congo and Amazon, the frigid rocky wastes of the far north—to remote mining camps, trading posts, rubber camps and coffee plantations—the helicopter avoids the hazards and discomforts of surface transportation.

Yes, in the postwar era, the helicopter should play an important part in helping to develop areas rich in mineral and agricultural resources—heretofore unexploited due to inaccessibility.

At McDonnell, in addition to making planes, parts and plastics for war, we're engaged in comprehensive helicopter development work . . . which will make possible, postwar, swift dependable transportation to remote points—at costs almost unmatchably low per ton-mile.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS ★ SAINT LOUIS-MEMPHIS ★

Curtis

SETS THE STANDARD

The "Quality" demanded by Curtis Universal Joint "Standards" gives every user of Curtis Joints a product that meets and surpasses rigid and strenuous wartime needs.

Each part shown has special features—successfully proven in hundreds of applications by airplane and machine tool industries.

Twenty years of experience selecting the right steels, special heat treatments developed by Curtis, careful machining to close tolerances, finished ground surfaces all accurately fitted to give positive, free articulation, are incorporated into each part.

Figs. 1 & 2 FORKS — heat treated to secure maximum toughness and strength, inside ear surfaces accurately ground for close, smooth working operation, pin holes broached and honed for perfect alignment, the O. D. cylindrically ground for concentricity.

Fig. 3 CENTER BLOCK — holes intersecting accurately in the center, with the faces parallel, hardened and precision ground for long wear, with recess for the Telltale Lock ring.

Figs. 4 & 5 PINS — hardened and centerless ground to close tolerances reduce radial play.

Fig. 6 OILER — Curtis pioneered proper and essential lubrication, and made it easy by furnishing patented oilers in the large pin.

Fig. 7 "TELLTALE" LOCK RING — patented by Curtis — snaps into small pin groove and fits recess of center block. This insures firm, positive lock-up of entire assembly — makes disassembly and reassembly quick and easy, and the "Telltale" end shows at a glance that the ring is in proper locking position.

Curtis Engineers can help solve your universal joint problems. Our experience and knowledge is yours for the asking.

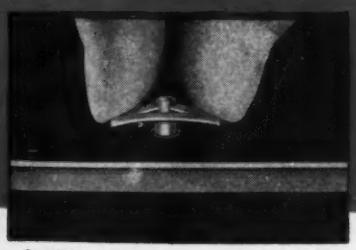
CURTIS UNIVERSAL JOINT CO. INC

SPRINGFIELD, MASS. • BOSTON GEAR WORKS, NO. QUINCY, MASS., SOLE DISTRIBUTO

ONE OF A SERIES PORTRAYING "THE SPEED NUT FAMILY OF FASTENERS"

PUSH-ON SPEED NUT

JUST A *Push* AND IT LOCKS!



SPEED NUT is started over stud by hand . . .

. . then pushed down on stud with tool.

Parts are held together with firm spring tension lock.

● It's just as simple and easy as that! For this unique spring steel fastener needs only to be *pushed* over rivets, nails, tubing, wire, integral die cast or plastic studs to lock parts firmly together. Threads are unnecessary because the spring prongs of the nut provide a friction *lock* on even the smoothest of chrome surfaces.

But easy attachment is not the only advantage gained by using Push-On type SPEED NUTS. Costly threaded inserts, drilling and tapping are eliminated — molding costs reduced — assembly speeded up — and vibration loosening prevented. These fasteners are available in many sizes and shapes . . . rectangular, square, round, or they may be specially designed to fit your particular requirements.

If you want to improve the attachment of name plates, emblems, trim strips, grilles, or other light-weight parts, write now for samples of Push-On type SPEED NUTS, giving *stud diameter* and any other pertinent assembly details.

TINNERMAN PRODUCTS, INC.
2070 FULTON ROAD, CLEVELAND 13, OHIO
In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In England: Simmonds Aerocessories, Ltd., London

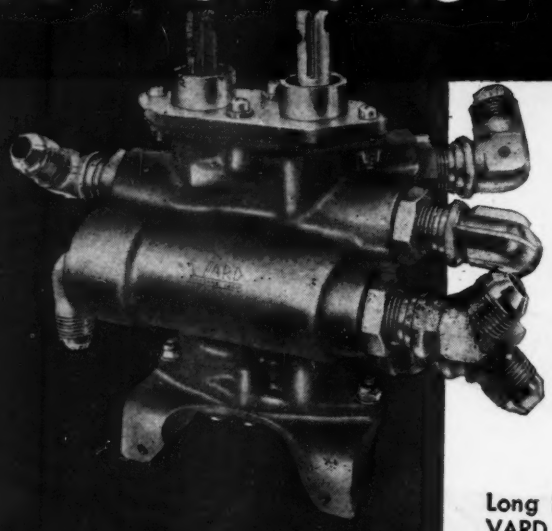
Speed Nuts* PATENTED

FASTEST THING IN FASTENINGS

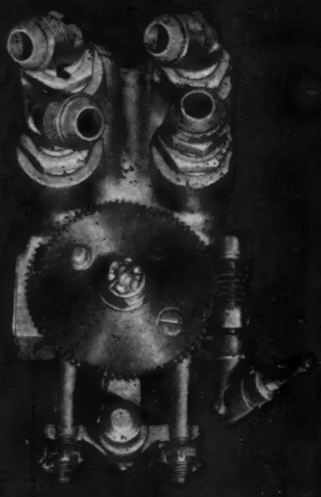
*Trade Mark Reg. U. S. Pat. Off.

THE BASIC PRINCIPLE of Spring-Tension Lock is Embodied in all Speed Nut Designs

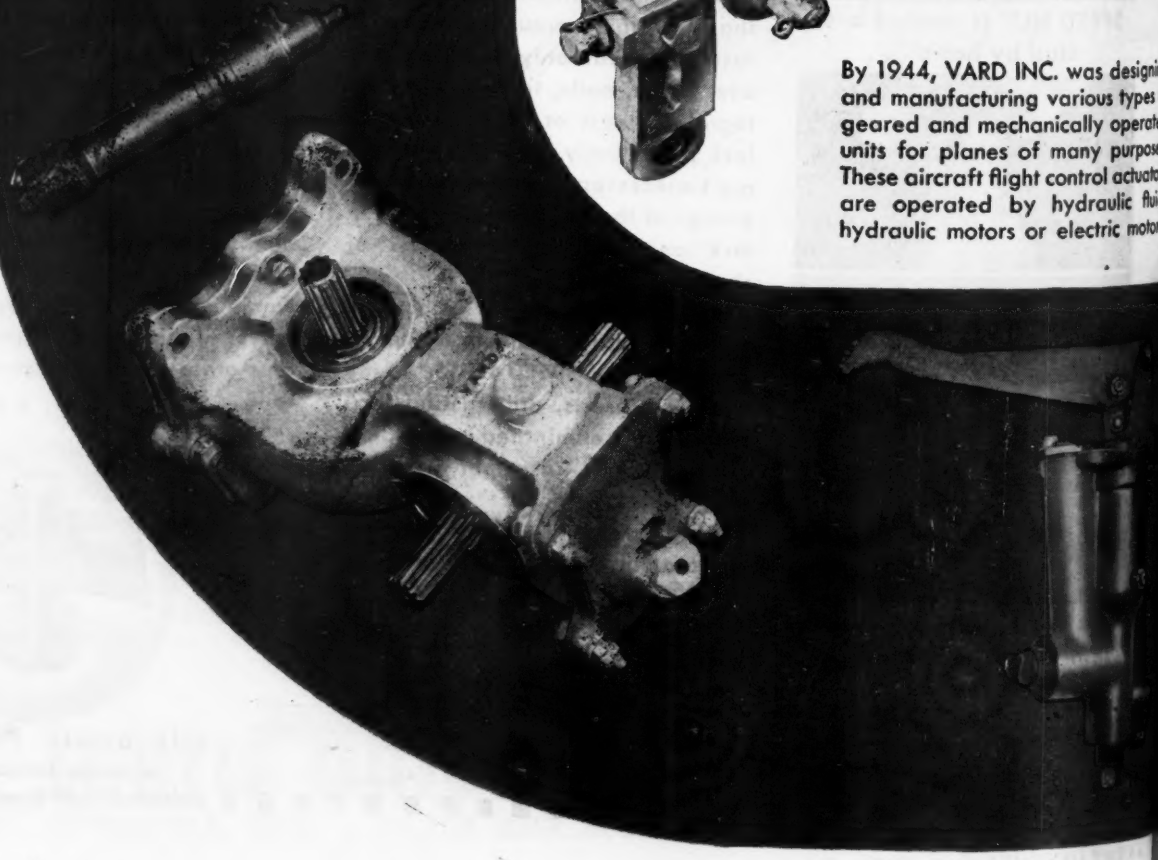
OUT OF PAST EXPERIENCE -



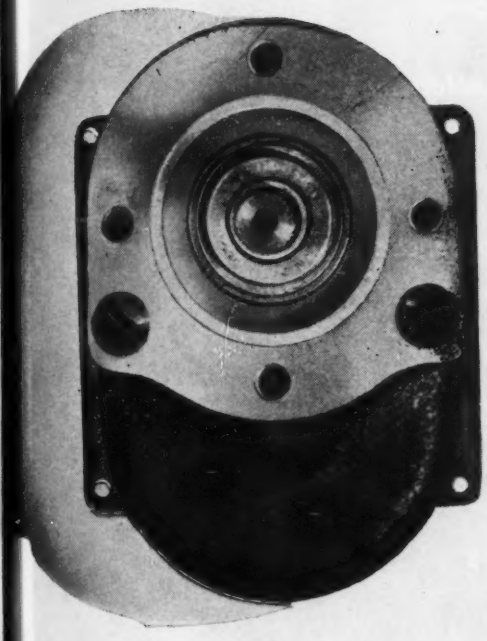
Long before Pearl Harbor, VARD INC. was designing and manufacturing all kinds of actuating equipment for the aircraft industry. Our first units were all hydraulic types.

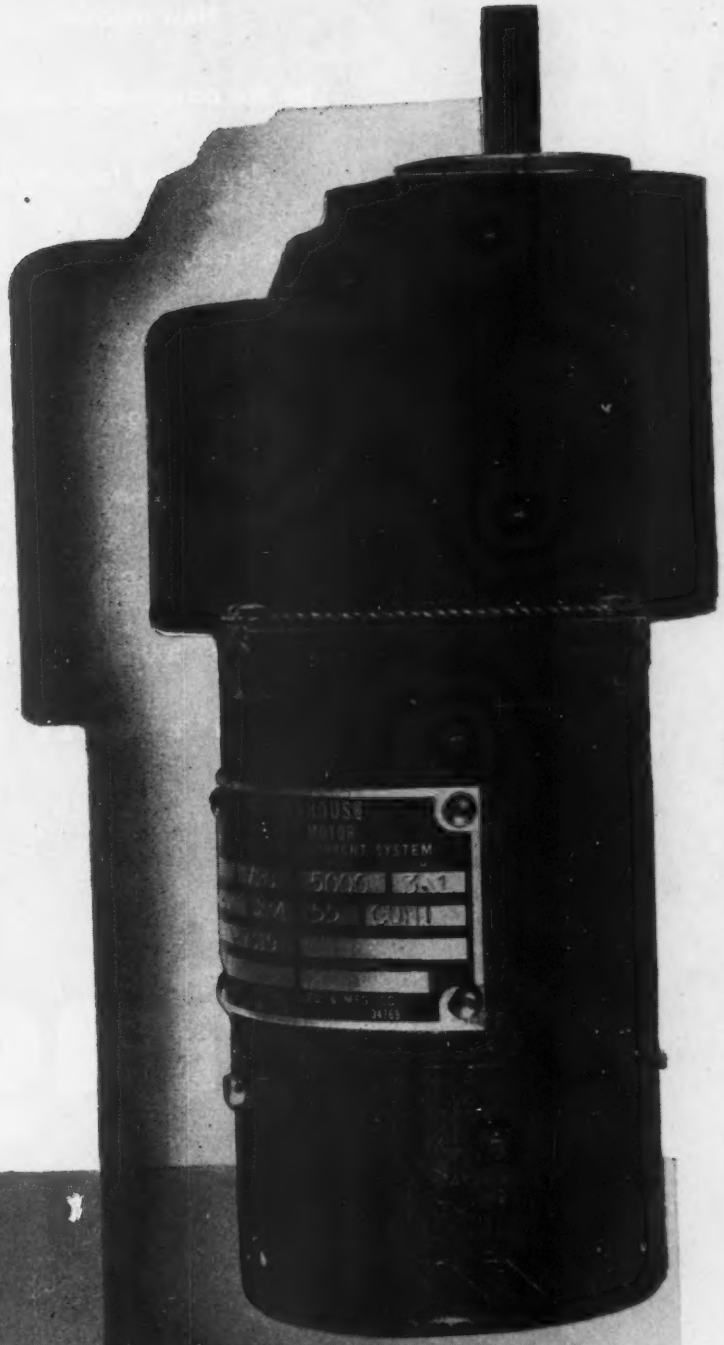


By 1944, VARD INC. was designing and manufacturing various types of geared and mechanically operated units for planes of many purposes. These aircraft flight control actuators are operated by hydraulic fluid, hydraulic motors or electric motors.



-E PRODUCE A NEW SMALL ACTUATOR





HIS IS THE ACTUAL SIZE

cognizing the need for a small, reliable, torque actuator, we have designed and are building this et of power, as shown here in actual size. It weighs 6 oz. This little unit can operate an aerial camera, ra doors or other small doors, trim tabs, remote or hydraulic valves. It can be supplied with brake clutch by adding slightly to length and weight of odel illustrated.

e distinct advantage in this actuator is the fact the electric motor can be removed without other-

SPECIFICATIONS

length — with motor	7-in.
width — "	2-5/16-in.
height — "	3-in.
— "	2 lbs. 6 oz.
Shaft Speeds (available as specified)	12½ rpm. 15 rpm. 20 rpm. 25 rpm.
—Heat-treated spur gears. Capable of handling motors of 1/50 to 1/15 h.p.	
—(Westinghouse). Can furnish ran-cooled, totally enclosed or open type as shown.	24 Volt D.C.

VARD INC.
PASADENA 8, CALIF.

New machines of all kinds will be improved

by the advanced Cast Bronze Bearings

developed for aircraft engines.

In precision, finish, and metallurgical uniformity

Bunting Cast Bronze Bearings, today, surpass

any bronze bearings ever before produced in volume.

The Bunting Brass & Bronze Company, Toledo 9, Ohio.

Warehouses in principal cities. 10

BRONZE BEARINGS ★ BUSHINGS

★ PRECISION BRONZE BARS

Bunting

Water Injection Corrosion

Solved by

Romec

• **Corrosion of Water Injection Pumps has been caused by electro-chemical action due to the water solution contacting two dissimilar metals. This has required the development of special internal insulation as well as external contact insulation.**

Write For Illustrated Folder

★

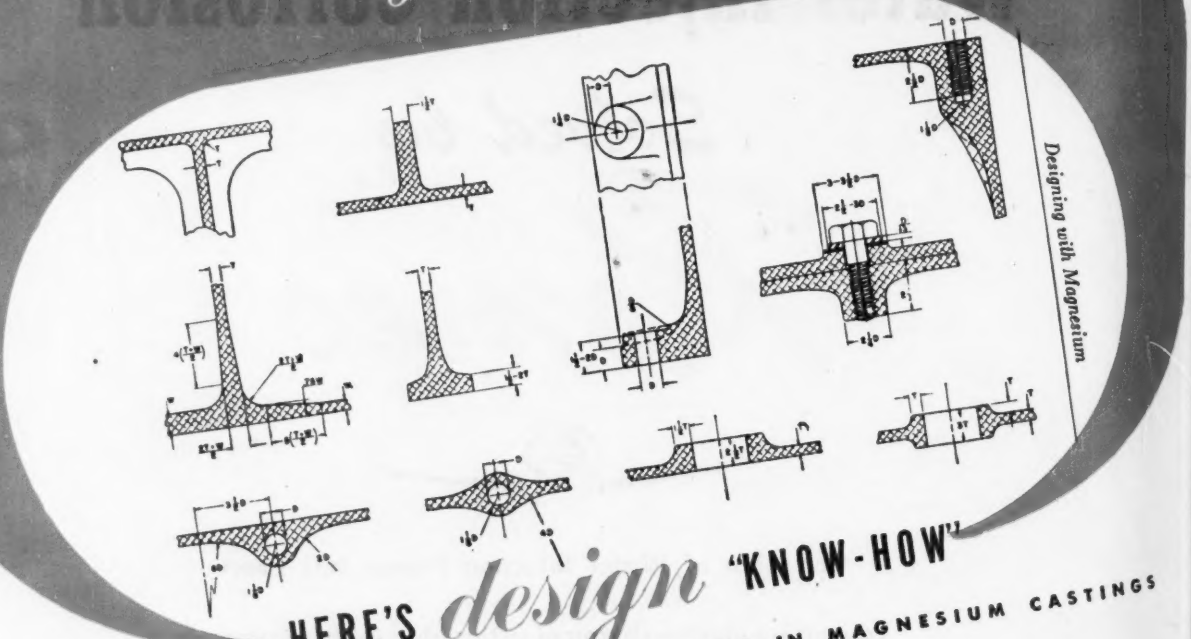
THE ROMEC PUMP COMPANY

117 ABBE ROAD • ELYRIA, OHIO • U. S. A.

Manufacturers of FUEL PUMPS—Electric and Engine Driven. TRANSFER PUMPS, Booster Pumps, Tank-Mounted Fully Submerged Pumps, VACUUM PUMPS, Pressurizing Pumps. OIL PUMPS, Glycol and Circulating Pumps.

AMERICAN MAGNESIUM CORPORATION OFFERS YOU "KNOW-HOW" IN

design... manufacturing



HERE'S *design* "KNOW-HOW"

EXAMPLES OF SECTION JUNCTIONS AND EMBOSSING IN MAGNESIUM CASTINGS

Help yourself to more than twenty years of experience in working with magnesium. American Magnesium will gladly share the "know-how" gained through many years of designing, manufacturing, and assembling magnesium parts.

This experience translates itself into better products for you—more efficient designs, maximum savings in weight. Then, as you place your designs in production, look to American Magnesium for dependable castings, forgings, extruded shapes, and sheet.

May we assist you in employing the weight-saving properties of magnesium to best advantage? Write to Aluminum Company of America, Sales Agent for Mazlo Magnesium Products, 1713 Gulf Building, Pittsburgh 19, Pennsylvania.

MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

AIRCRAFT INSTRUMENTS

by GENERAL ELECTRIC

Sixth in a series showing a few of the many AIRCRAFT INSTRUMENTS that G.E. is building for war and will continue to build in peacetime

GENERAL ELECTRIC

SCHENECTADY, N.Y.

CHALLENGE TO YOUR ENGINEERING VISION

MORAINE
POROUS METAL
(COMMONLY KNOWN AS POREX)

In Moraine Porous Metal, designers and engineers have an outstanding new material to work with . . . a material that stimulates the imagination with its wide range of applications. Wherever product performance can be improved through filtration, separation, diffusion or flow control of fluids, air or gases, Moraine Porous Metal brings new efficiency to the job.

THESE EXAMPLES SHOULD GIVE YOU A LEAD

Diesel Engines: A small Moraine Porous Metal element, fabricated as a cone and bonded to a metal washer, filters the fuel oil as it enters the injector nozzle—safeguards fine orifices against clogging. *Refrigeration Equipment:* Moraine Porous Metal elements separate oil from the refrigerant, and protect control valves, expansion valves and compressor by removing harmful substances. *Pneumatic Tools:* To safeguard fine orifices in pneumatic tools, Moraine Porous Metal elements filter out harmful dirt. *Lubricated Products of All Types:* Wherever precision parts or polished surfaces must be safeguarded against dirt from lubricating oil, Moraine Porous Metal filters provide effective protection. *Explosion-Resistant Electric Motors:* Where motors must operate in an explosive atmosphere, Moraine Porous Metal vents serve as flame arrestors, permitting the motors to "breathe," yet preventing ignition of the combustible mixture outside them.

BUY AN EXTRA BOND THIS WEEK

MORAINE PRODUCTS Division of GENERAL MOTORS

NORTON *Vitrified* DIAMOND WHEELS

[PATENTED]

ANOTHER outstanding Norton diamond development—the sensational VITRIFIED BONDED DIAMOND WHEEL. . . . Combining the fast cutting action of the Norton Resinoid Bonded Diamond Wheel (introduced in 1934) with the long life of the Norton Metal Bonded Diamond Wheel (1939).

The Norton Vitrified Bonded Diamond Wheel is available in a range of sizes including the popular 6" x 3/4" and 4" and 6" chip breakers—and there's also the Norton Vitrified Bonded Diamond Hand Hone.

Actual plant tests have proven two to four times greater life while cutting 50% faster.

Another example of Norton research and leadership.

NORTON COMPANY, Worcester 6, Mass.

Behr-Manning, Troy, N. Y., is a Norton Division

NORTON ABRASIVES

Lightweight, Compact, Efficient . . . that's Fluid Heat Aircraft Heaters

FLUID Heat Aircraft Heaters emphasize lightness, compactness, efficiency. Typical of the complete line is model SRH-15, which weighs only 6 pounds, 14 ounces, *complete with all controls and accessories*, yet delivers 15,000 BTU per hour under flight conditions. Ideal for single and two-place airplanes, it is available with blower for ground operation. Transfer between ground and flight phase is automatic, assuring continuous service.

The same outstanding lightness and compactness feature all models of Fluid Heat's complete line of aircraft heaters. The 100,000 BTU unit weighs but 24½ pounds, measures 9 inches in diameter by 27 inches in length. The 50,000 BTU unit measures 6½ inches by 20 inches, weighs only 16 pounds, 10 ounces. *These weights include all controls and accessories.* Blowers are available for ground operation, with automatic transfer between flight and ground phases assuring continuous service.

Built around a new heating principle of special advantage in aircraft heating, these super-light heaters employ a vapor-entraining combustion process utilizing pre-heated combustion air. The process accomplishes combustion with an unusually low pressure drop, permitting operation at low ram pressures. It produces a completely suspended fire and therefore gives freedom from lead oxide formation. Flame retention is so positive that flame characteristics are the same under all conditions. Automatic compensation assures high combustion efficiency from sea level to ceiling.

Fluid Heat has, for seventeen years, led in the development and manufacture of automatic combustion and heat transfer equipment. Those years of heat engineering know-how are built into each light, compact, efficient Fluid Heat Aircraft Heater. You will want Fluid Heat Aircraft Heaters on planes you design, build or equip. Write for full information on this new heating achievement.

FLUID HEAT DIVISION
Anchor Post Fence Co.
6740 Eastern Ave., Baltimore 24, Md.

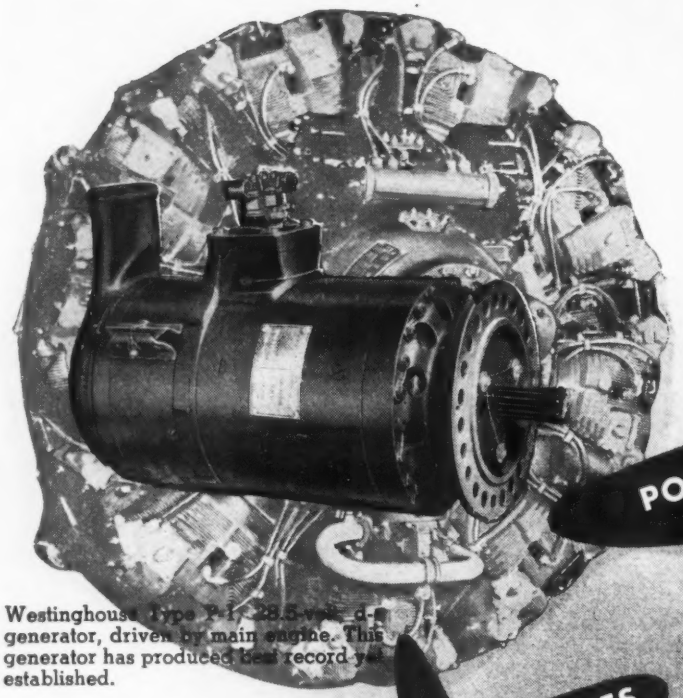
FLUID HEAT'S MODEL SRH-15 HEATER

Though it weighs only 6 pounds 14 ounces, *complete with all controls and accessories*, this heater has a maximum output of 15,000 BTU in flight. Dimensions are 4⅝ inches by 18¾ inches. As for all models, blower is available for ground operation.

fluid heat
AIRCRAFT HEATERS

WESTINGHOUSE...

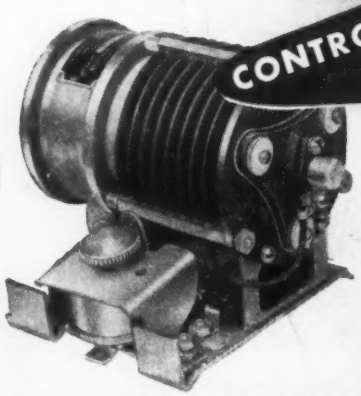
working partner of the aviation industry...



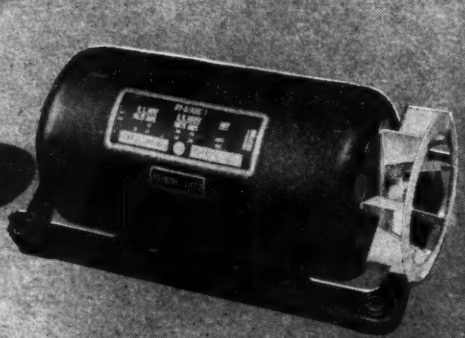
POWER SOURCE

Westinghouse Type P-1, 28.5-volt d-c generator, driven by main engine. This generator has produced best record yet established.

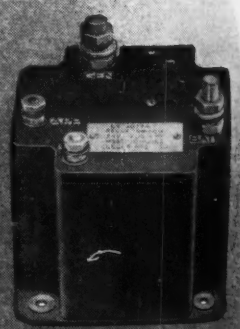
CONTROL ACCESSORIES



Westinghouse Carbon Pile Regulator keeps voltage output of generator constant in spite of generator load and engine speed variations. Used with the Westinghouse Stabilizing Transformer, it provides a high degree of stability and accuracy.

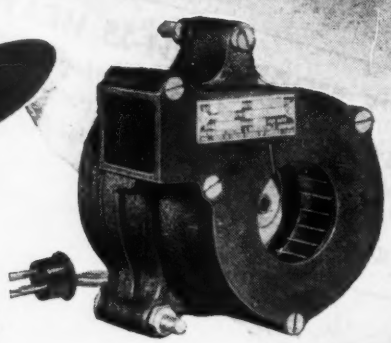


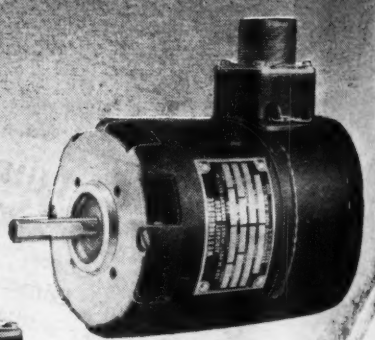
Westinghouse Dynamotors transform d-c voltage from the generator, to higher or lower d-c voltages for communications and electronic equipment.

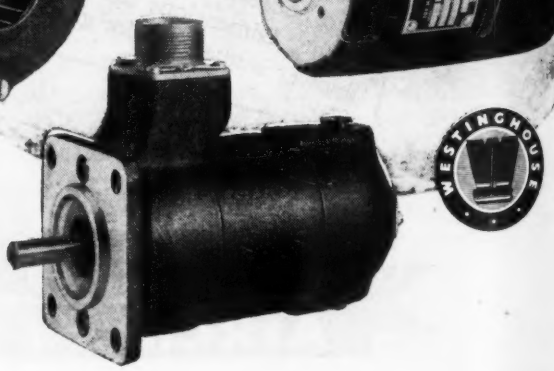


Westinghouse Differential Voltage Relay Switch closes when generator voltage reaches one-half volt above bus voltage.

MOTOR DRIVES







Westinghouse Motors are being built and supplied to perform a complete range of auxiliary functions in planes. All are designed to meet essential aviation requisites in motors: light weight plus ability to withstand extremes of temperature, altitude and humidity.

...FROM RPM...TO VOLTS...TO RPM

To do electrically the many things required to operate today's planes takes three different major types of electrical equipment. Each is a field of study in itself.

First, a means is needed for changing engine revolutions into electrical energy.

Then, control must be supplied . . . to compensate for changes in load and engine speed . . . to automatically connect or disconnect generators with the power system . . . to transform d-c power to higher or lower voltages for different jobs.

Finally, electrical energy must be converted back to rpm . . . to move wing flaps . . . to retract wheels . . . to rotate turrets.

There are few sources in the world with a firsthand background of experience in all three fields—especially as applied to aviation problems.

Westinghouse is one.

Westinghouse experience in building airplane generators began with the first ever built—wind-driven types to power World War I pioneer aircraft radio.

Dynamotors and control, likewise, date their development with Westinghouse from World War I.

Westinghouse aircraft motors date back to the first applications on the Shenandoah and the Akron. Additional applications have come as electrical systems were expanded, beyond the needs of lighting and radio communication.

This leadership continues—and will continue. Important present-day developments . . . high-altitude brushes . . . alternating-current power systems . . . are Westinghouse developments. Others are in progress. Together, they offer sound reasons for making Westinghouse your working partner in aviation progress. Westinghouse Electric & Manufacturing Company, Lima, Ohio.

J-03217

Westinghouse

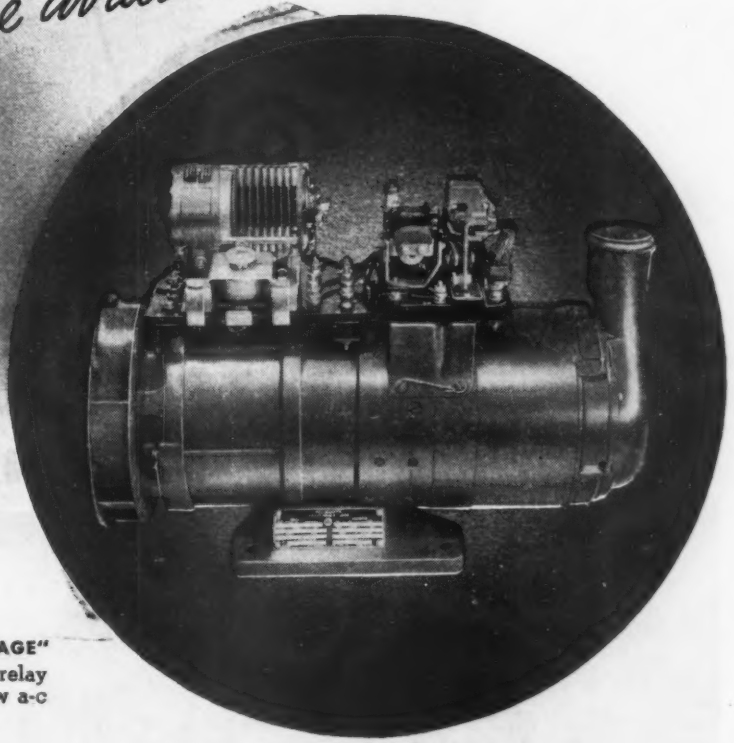
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electrical partner of the aviation industry

YESTERDAY...

TODAY...

TOMORROW



NEW A-C, D-C GENERATOR "PACKAGE"
Complete with voltage regulator and relay switch, designed to operate from new a-c systems in planes.

POWER TO WIN

All Continental Red Seal Engine parts are scientifically coordinated to insure economy and smooth operation.

Continental Red Seal Power — The Power to Win — is the result of an extraordinary ability to produce — an ability that comes from years of skilled experience and the use of modern and efficient manufacturing equipment.

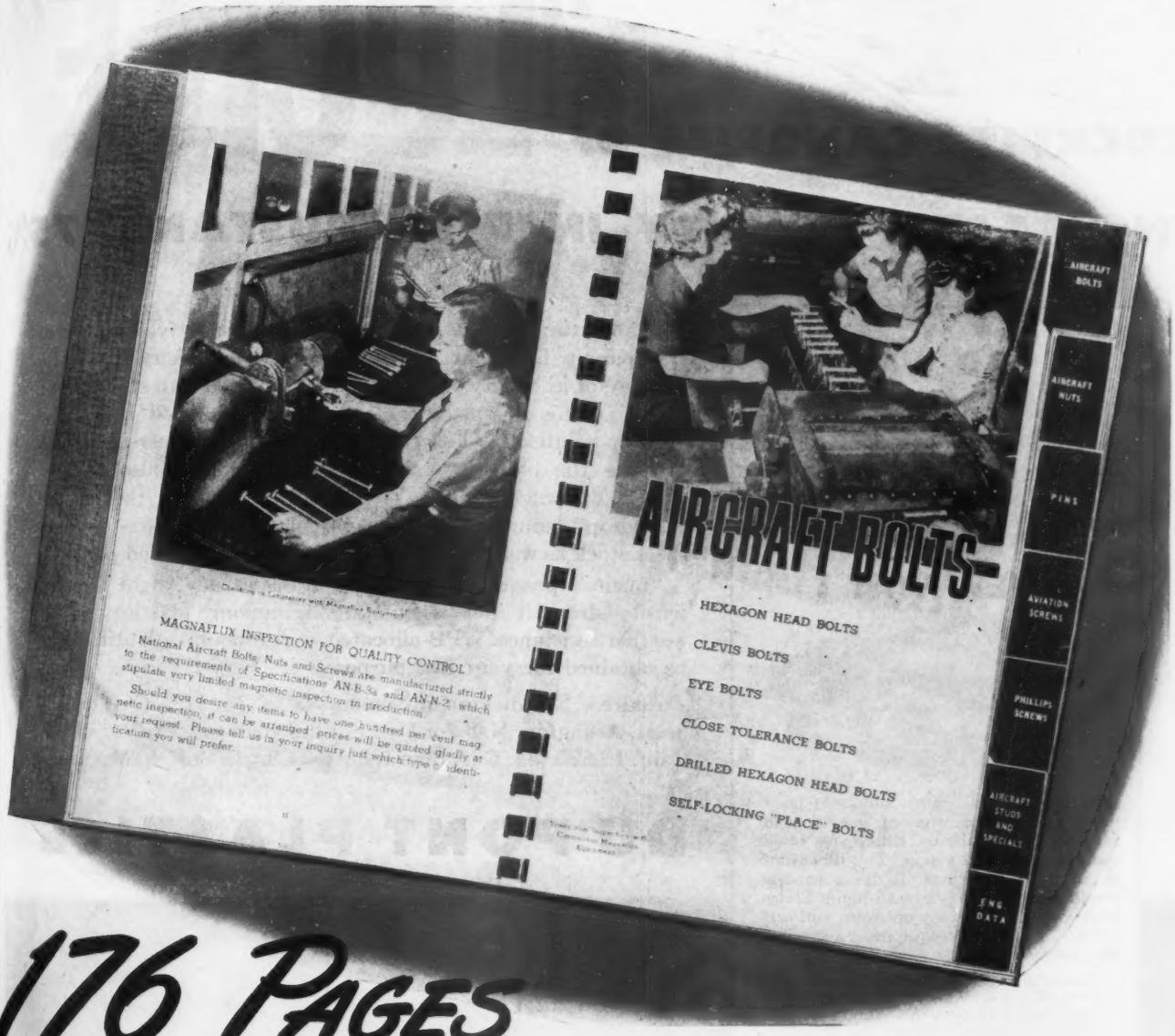
Your Dollars Are Power, Too!
Buy War Bonds and Keep Them!

Continental Motors Corporation

Aircraft Engine Division
MUSKEGON, MICHIGAN

ARMY E NAVY

Awarded to the Detroit and Muskegon Plants of Continental Motors Corporation for High Achievement


AIRCRAFT BOLTS
AIRCRAFT NUTS
PINS
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AIRCRAFT STUDS AND SPECIALS
ENG. DATA
AIRCRAFT BOLTS—
HEXAGON HEAD BOLTS
CLEVIS BOLTS
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CLOSE TOLERANCE BOLTS
DRILLED HEXAGON HEAD BOLTS
SELF-LOCKING "PLACE" BOLTS
MAGNAFLUX INSPECTION FOR QUALITY CONTROL
National Aircraft Bolts, Nuts and Screws are manufactured strictly to the requirements of Specifications AN-B-3a and AN-N-2, which stipulate very limited magnetic inspection in production.
Should you desire any items to have one hundred per cent magnetic inspection, it can be arranged—prices will be quoted gladly at your request. Please tell us in your inquiry just which type of identification you will prefer.

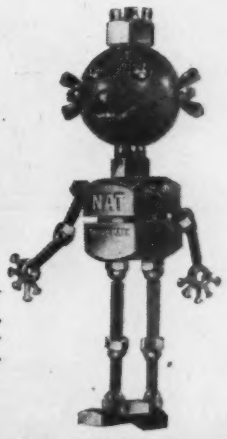
176 PAGES

OF AIRCRAFT FASTENERS BY National HEADED AND THREADED PRODUCTS

Here's a valuable new catalog for the man who is interested in aircraft fasteners . . . the most complete of its kind ever published. It contains complete tables of AN and NAS Bolts, Nuts, Screws, Rivets and other products.

National Aviation Products include many special parts, such as carburetor studs, motor mounting bolts, stainless steel instrument screws, brake adjustment screws, gyroscope struts, dome nuts—to name just a few.

An indication of our success in meeting the exacting requirements of the Air Forces is the fact that the Air Technical Service Command has designated this company as a "Quality Control Approved Facility".



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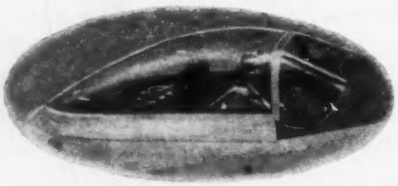
THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

COCKPIT CANOPIES OF "LUCITE"

INCREASE VISIBILITY IN P-51 MUSTANG 75%

OLD WAY

NEW WAY



Advantages: Replaces old-style hood made of eight transparent panels, held together by metal ribs. Eliminates blind spots, permits full vision in all directions in all flying positions. Reduces canopy production time 45% in man-hours. Slides back and forth for easy entrance and exit of pilot. Makes radio equipment accessible instantly.

Canopy formed by Swedlow Aeroplastics Corp., Glendale, Calif., for North American Aviation, Inc., Inglewood, Calif.

P-51 Mustang pilots now fly under a protective canopy of transparent Du Pont "Lucite" methyl methacrylate resin. Because of its ability to be heated and formed into streamlined contours, this one-piece enclosure can be shaped by a new vacuum method in less time than was formerly required to produce the old-style canopy. This technique also reduces optical distortion during forming. In addition, the plastic "teardrop" reduces riveting operations and operations on alloy sheet stock as well as eliminating the use of machined parts.

"Lucite" possesses remarkable transparency, light weight, tensile strength and is outstanding among plastics for its weather resistance. WPB-allocated, experimental quantities can be obtained for your test purposes.

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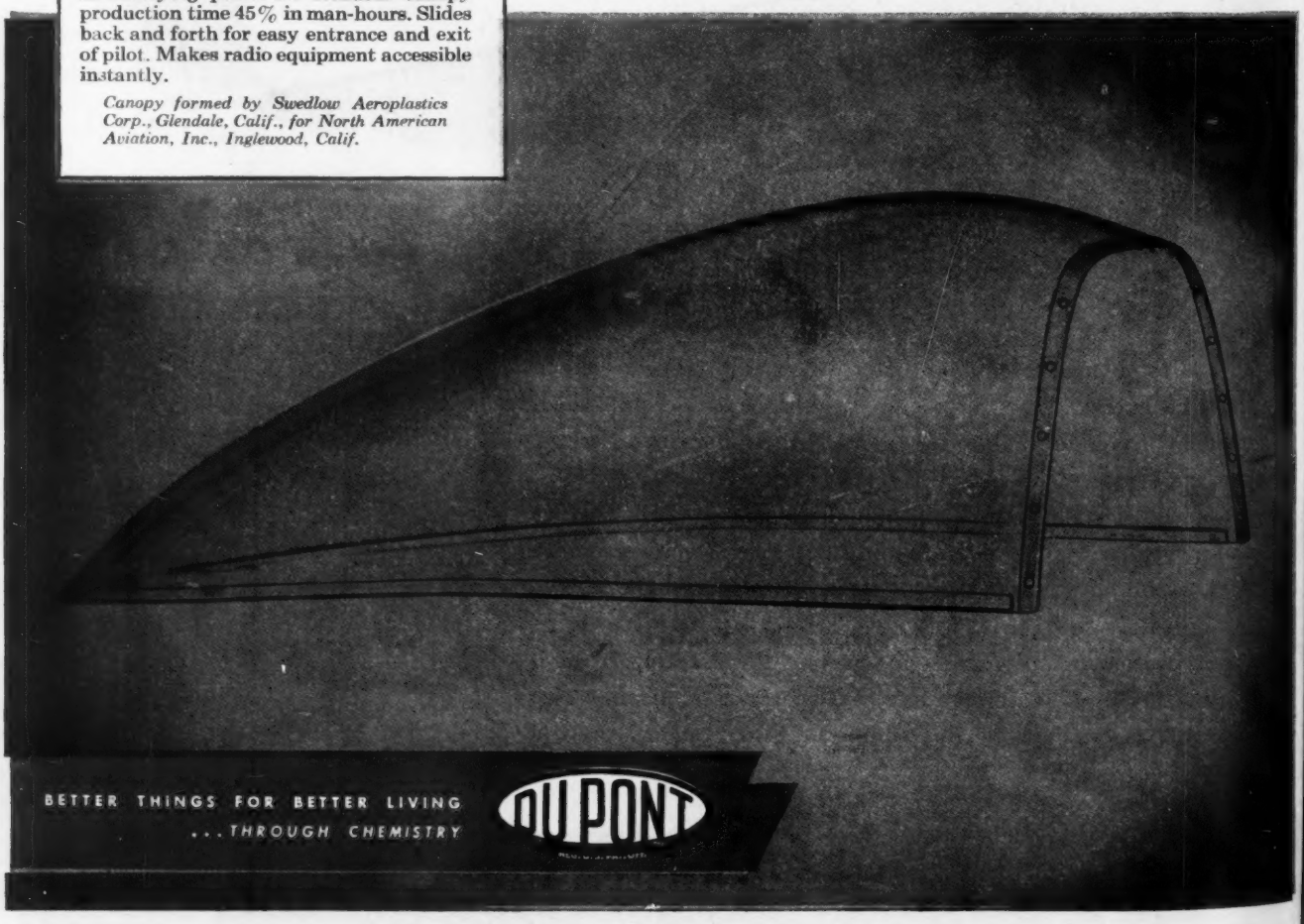

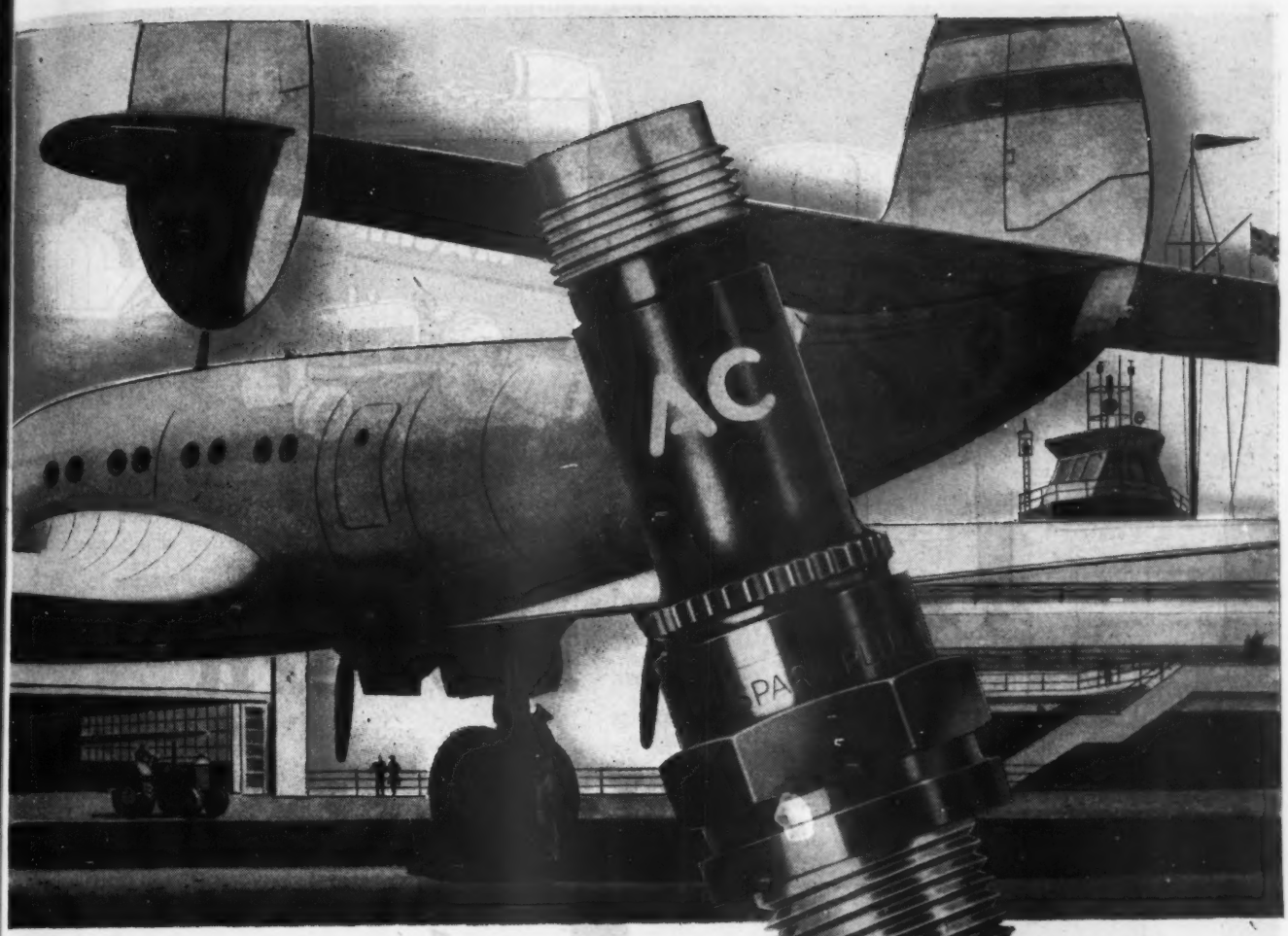

THE FUTURE BELONGS TO THE *Pioneer*

Remarkable as the progress in air travel has been to date, important secrets of its future are still half-formed in laboratories or withheld for military security.

AC first responded to the challenge of aircraft needs in World War I, as the exclusive builder of ceramic plugs for Liberty engines.

Further AC developments of the ceramic type helped to make possible the historic flights of Lindbergh, Maitland, Acosta and Byrd. Still fresh in our minds is the record transcontinental run last April of the transport ship, "Constellation," equipped with improved AC ceramics. And new heights of performance have been reached and maintained by AC ceramic plugs in Army Air Force planes throughout the world.

The record shows that AC "know-how" has kept step with airplane development, continuously pioneering to achieve air travel's goal of *utmost reliability.*

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under all CONDITIONS!
Designed to meet YOUR
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Special Qualities of Fasteners

that improve products and help fabrication

UNIFORMLY ACCURATE

Modern manufacturing methods as employed by fasteners makers, produce fasteners in large quantities having the degree of precision in dimensions required for fabrication of structures of all types. Whether your requirements are for extremely close tolerances for precision work, or high grade commercial quality, the products of up-to-date fasteners manufacturers today are uniform and dependable.

HIGH TENSILES

Carefully selected alloy steels properly heat treated are used by manufacturers to increase tensile strengths for application requiring this property.

CORROSION RESISTANCE

Fasteners are made from corrosion-resisting metals, or protected by coatings such as zinc plating, galvanizing, etc., wherever corrosion resistance is required.

HIGH FATIGUE STRENGTH

In dynamically stressed studs, high fatigue strength can be obtained by proper design without any weight increase.

FLUSH HEADS

Several types of countersunk, recessed, flat and other heads for bolts, cap screws and rivets are standard production with most manufacturers for use where required for surface smoothness or close fitting parts.

SPECIAL FINISHES

In addition to regular ground, machined or polished surfaces, you can get fasteners that are cadmium or chromium plated or otherwise specially finished for appearance, protection or other reasons.

DUCTILITY

In many fastening jobs, a certain amount of ductility is desirable, and bolts or rivets providing that property can be obtained according to specification.

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This important and useful characteristic is readily obtainable in fasteners through modern hardening methods. The wide variety of materials from which fasteners are made permits a wide range of hardening.

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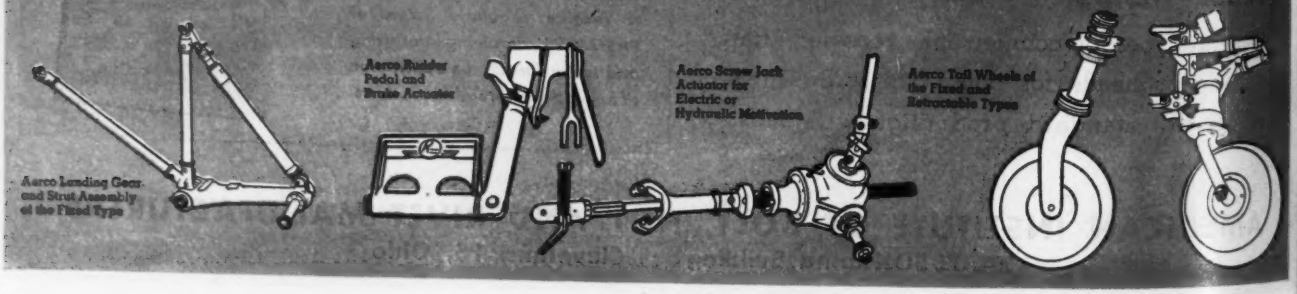
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THESE GAGES WERE NEEDED IN QUANTITY— AND THEY HAD TO BE RIGHT!!!!

The specifications called for a tapered involute spline ring gage less than 1/5" in diameter, with twelve teeth, evenly spaced and having an over-all accuracy that would permit full insertion of the master plug, without chatter or binding, at any tooth engagement. This is not an unusual order—we have others that are even more exacting—but we feel that it typifies the highly specialized engineering skill and fine workmanship that is integrated in all Vinco precision products. This exceptional ability to work consistently with microscopic dimensions and with such close accuracy is our assurance that if a gage can be built Vinco can build it.

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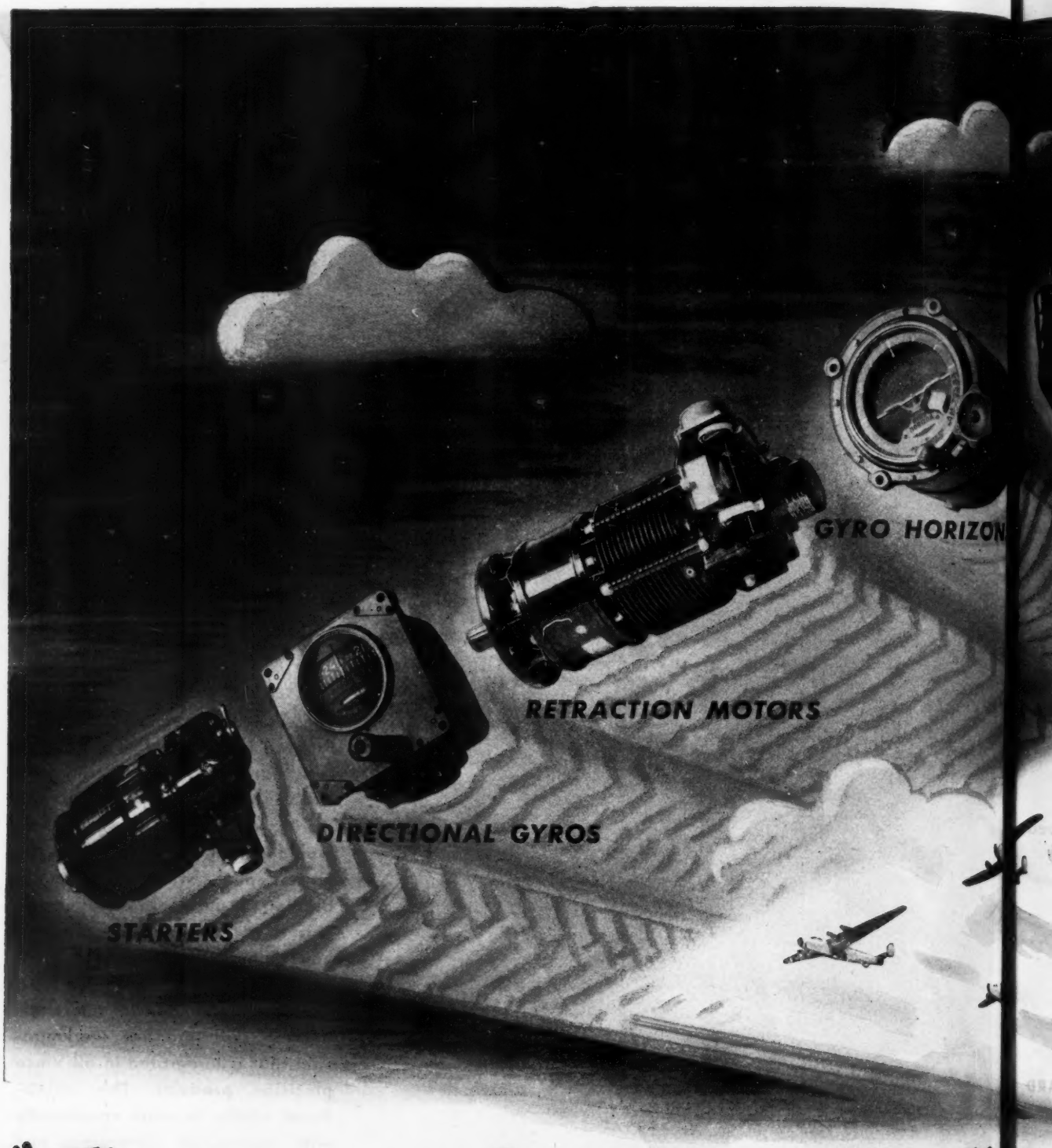
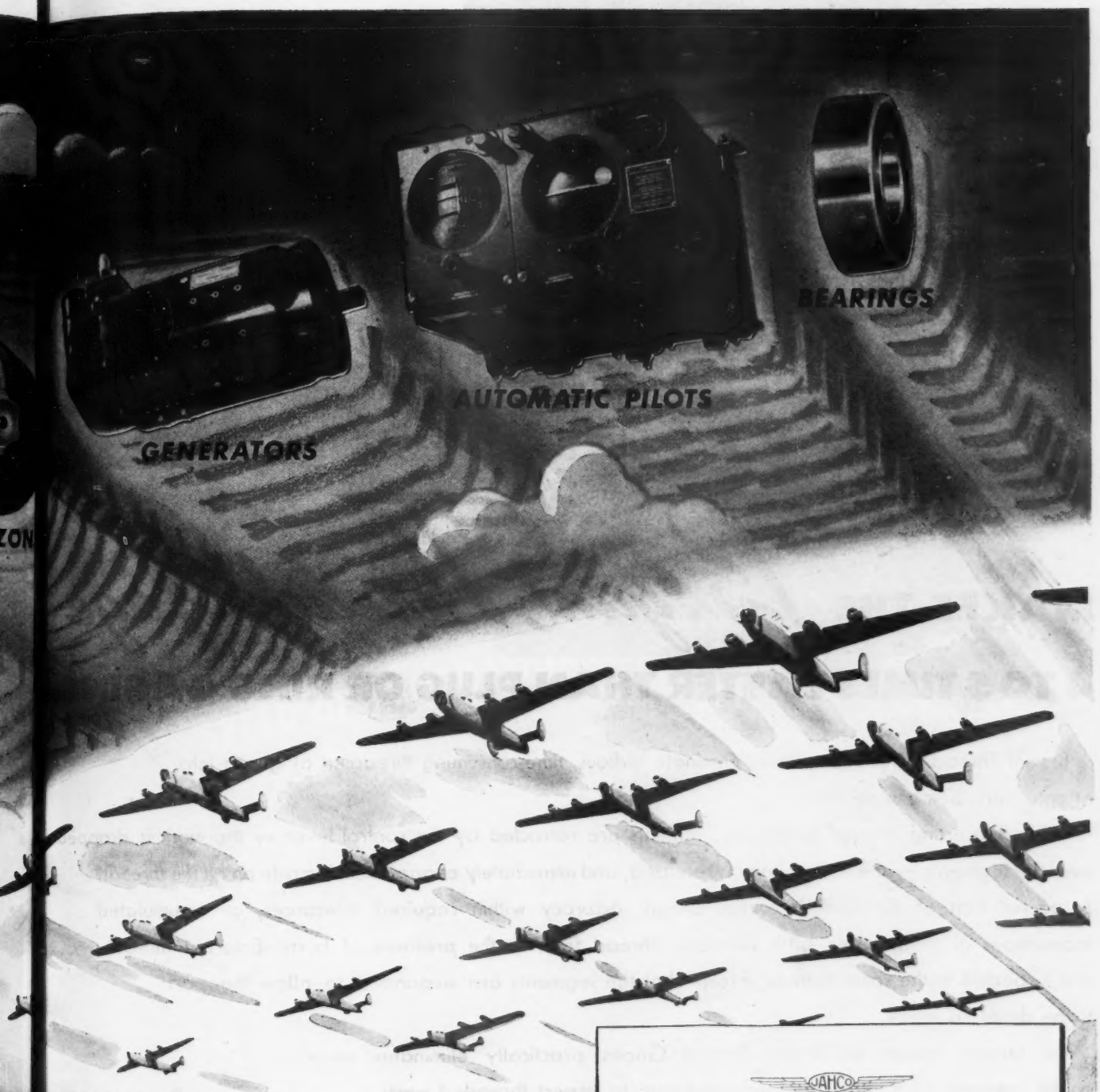


"These are a few we can talk a

Today, the eight Jack & Heintz plants are turning out 36 different war products—in unending streams for the finest aircraft in the world. Our newest assignments are military secrets, but jobs we *can* talk about now are the instruments, auto pilots, generators, starters, motors and bearings that have gone to war by the tens of thousands.

This equipment is used in pursuit planes, bombers, transports, patrol boats, trainers, gliders . . . and even blimps. Its performance has been such that the Jack & Heintz nameplate is now a welcome sign of dependability to the men who gamble their lives on it daily in every corner of the globe.

From the first, Jack & Heintz has led the



about now"

way in reducing weight, boosting output and increasing service life on every job undertaken. Engineering like this has helped keep America's air fleet first in the war . . . it will be equally effective in holding that place in peace.

Watch Jack & Heintz for new things in aircraft!

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4 TO 5 TIMES FASTER THAN PLUG OR RING GAGING

Bryant Thread Gages completely eliminate tedious, time-consuming threading of gages into or onto parts being inspected.

When inspecting internal parts, the segments are retracted by the control lever — the work is dropped over the segments — the control lever is released, and *immediately* engagement is made on *all the threads.* A *partial* turn of the work indicates overall accuracy within required tolerances, or accumulated inaccuracies of lead, taper, pitch diameter, thread form or the presence of burrs. External threads are inspected in the same manner, except that the segments are expanded to allow the part to be dropped inside.

The unique design of Bryant Thread Gages practically eliminates wear on the segments — it allows inexperienced help to inspect threaded parts four to five times faster than experienced inspectors using conventional gages — it eliminates the "feel" required in plug and ring gaging — it offers a method for complete, overall inspection of master plug and ring gages, and a method of transferring their accuracy to production threaded parts.

Write today for illustrated folder No. G2 which gives complete details.

BUILT IN 3 STANDARD MODELS

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Why HANSEN COUPLINGS are so widely used

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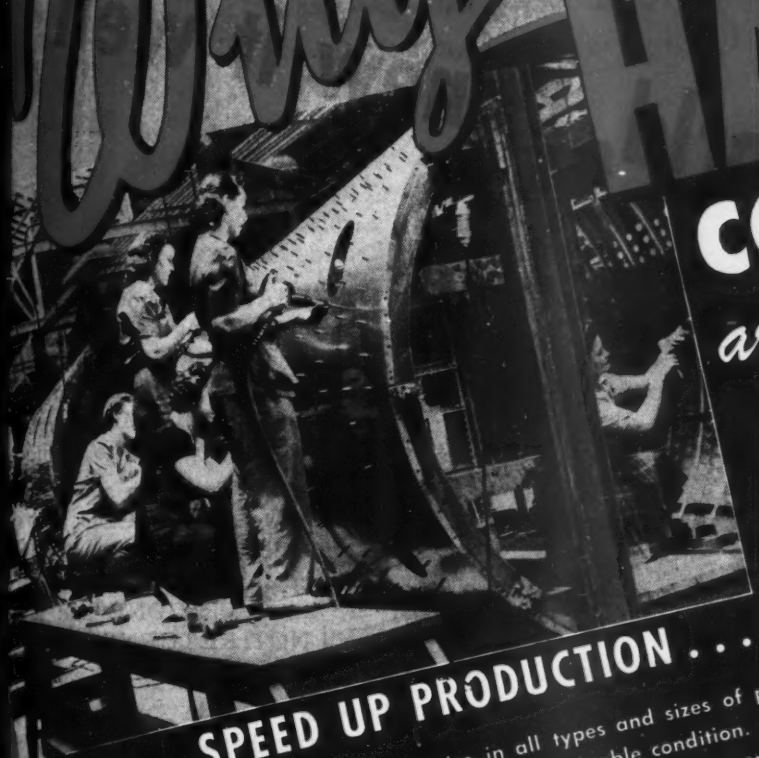
THEY'RE EASIER TO HANDLE, FASTER, LONGER LIFE, CUT DOWN COSTS



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Hansen Couplings are first choice in all types and sizes of plants throughout the world because of their remarkable performance under every conceivable condition. • Simplicity in design means faster and easier operation, greater production, less cost, less trouble, longer life. • Hansen Couplings will take pressures from 2 ounces to over 10,000 pounds without leaking. • They take rough treatment like a major because no parts are exposed, there's nothing to bend, jam or freeze. • Simplicity in operation is one Hansen feature that saves time, a lot of time. For instance, with a Hansen Air Coupling you merely push plug into socket, it is connected, locked and air is automatically turned on. To disconnect, merely slide sleeve back, it is unlocked, disconnected and air is automatically turned off.

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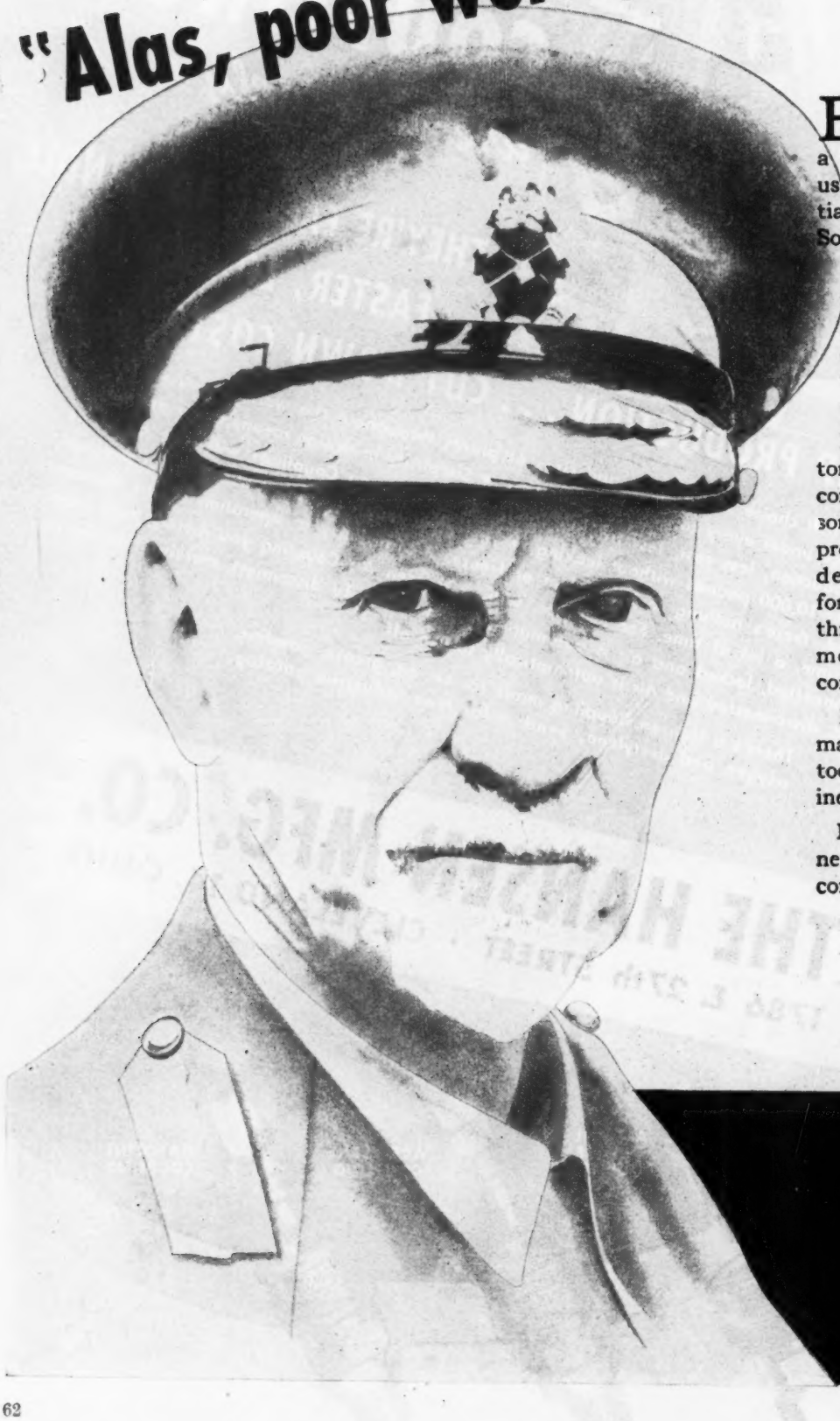
then he said to himself

"Alas, poor world, I knew it well"



EXPLAINING how the old map is being rolled up and a new map is unrolling before us . . . Field Marshal Jan Christiaan Smuts, Prime Minister of South Africa, went on to warn:

"We are living in a world where we are FORCED to a fundamental revision of old concepts. The old world that we knew has GONE and it will NOT RETURN!"

Be thankful that to many factory men here in America that conviction has already been absorbed, because the urgency for production . . . the urgency for development...the urgency for redesign has made evident, throughout these critical supply months, the need for better concepts.

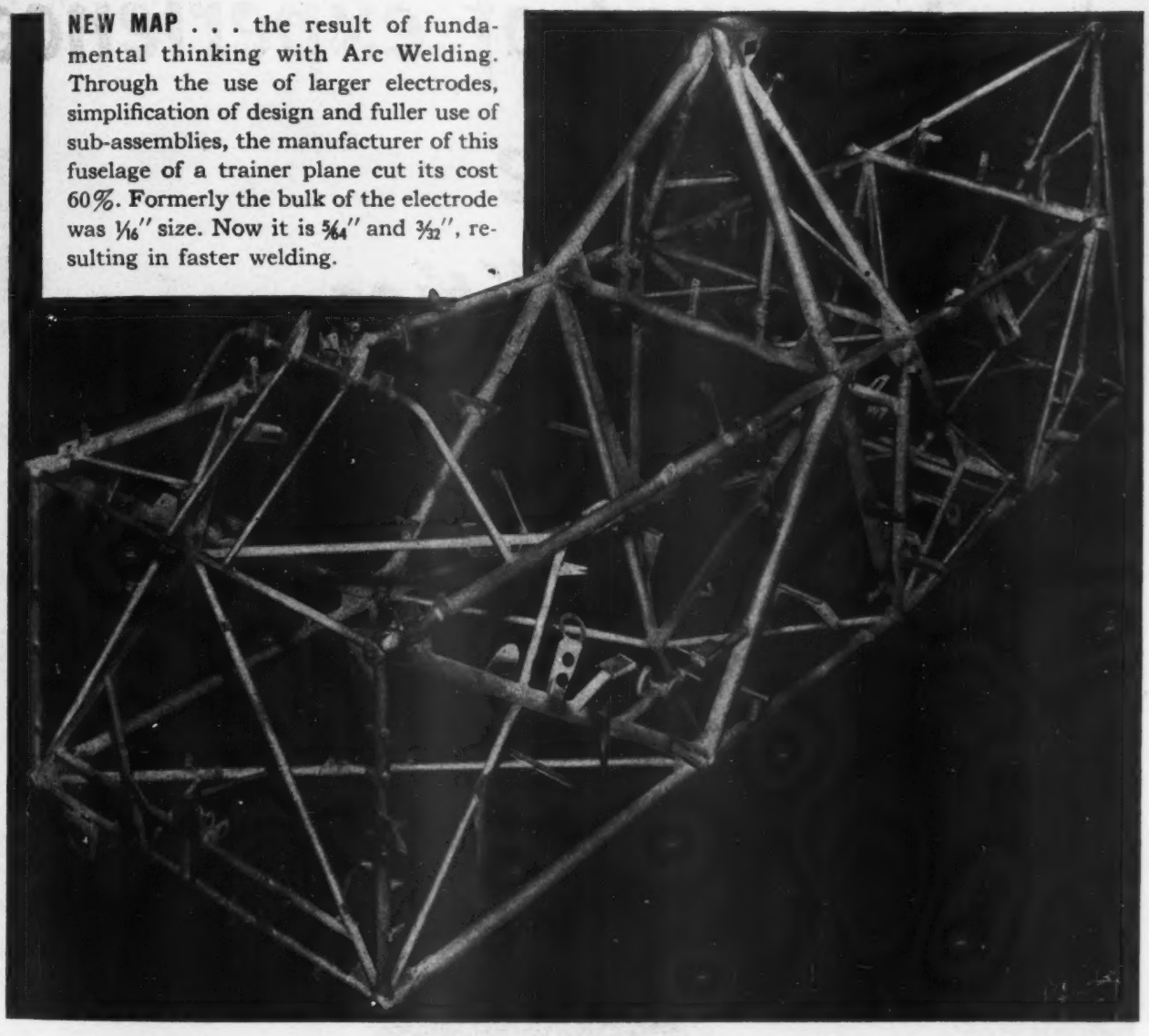
By following old concepts in manufacture, the materiel flowed too little and too late and too ineffectively.

Be thankful for the hundreds of new concepts that are now overcoming our peril. For example:

"A New Map is Unrolling," *he says*

LOOK, MARSHAL SMUTS, how fundamental thinking is revising old concepts in the design and production of aircraft structures:

NEW MAP . . . the result of fundamental thinking with Arc Welding. Through the use of larger electrodes, simplification of design and fuller use of sub-assemblies, the manufacturer of this fuselage of a trainer plane cut its cost 60%. Formerly the bulk of the electrode was 1/16" size. Now it is 5/64" and 3/32", resulting in faster welding.



The Lincoln Engineer nearby will gladly help you revise old concepts with Arc Welding.

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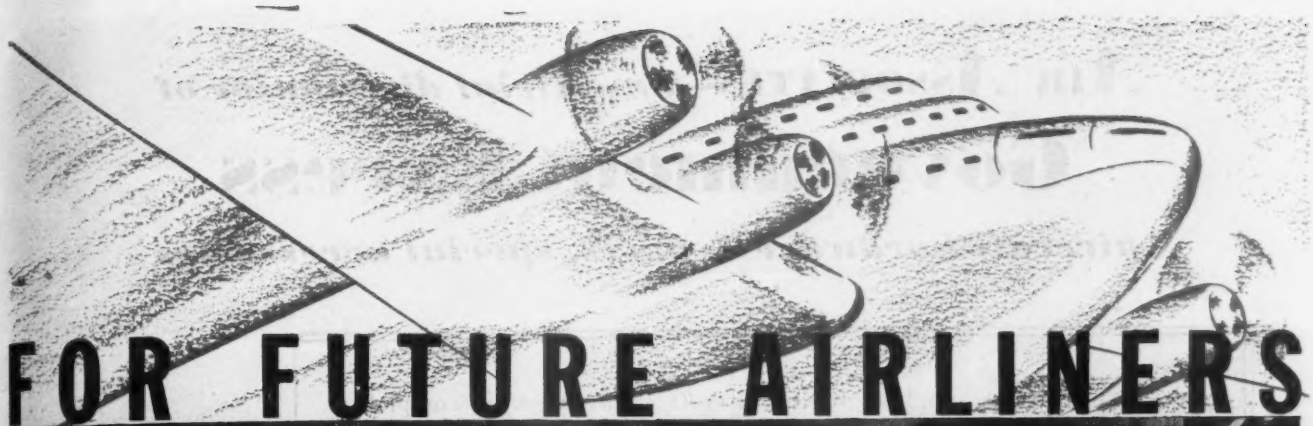

FOR FUTURE AIRLINERS

SPOTLESS *Charming Interiors*

Interior paneling, seat backs, kick plates in the airliner of the future will be decorative Formica.

The material has already served its apprenticeship in ships, trains, busses and in air, train and bus terminals.

It has proved that it has lasting beauty even in spots where wear is most severe. The hard non-absorbent surface does not stain. It resists mild acids, alkalies, solvents—so few ordinary liquids can mess it up. It saves cleaning time because a swish of a damp cloth or a washing with soap and water is sufficient. On table tops it is cigarette-proof. It is lighter than aluminum.

Plane designers know it well as used for control pulleys, air frame and propeller parts.

The range of charming colors, patterns, "Realwood" grains make it the leading modern decorative material where beauty must be preserved under severe conditions.

ARMY E NAVY

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THE FORMICA INSULATION COMPANY

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EXPERIENCED suppliers to the aircraft industry, with complete warehousing and distributing facilities at four centrally located points . . . Air Associates is privileged to serve as an agent in the important task of expediting Uncle Sam's program to—(1) eliminate additional production of items now stored in quantity in aircraft factories—(2) reduce these excess stock piles—(3) redistribute the excess in an orderly way, at lowest prevailing prices of comparable new production material! Available stocks include all AN standard hardware parts, all types of AN fittings, and all Standard and many special aircraft components. Items are new, unused, certified by government inspectors as "aircraft quality"...do not require subsequent inspections of any kind.

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Take advantage of this surplus!

You perform a patriotic service by helping to liquidate the excess—and help yourself by obtaining immediate delivery, without waiting for production!

***Wire your requirements to—*AIR ASSOCIATES, INC.,** Teterboro, N. J. · Chicago, Ill. · Dallas, Texas · Los Angeles, Calif.

The Cable that Helped Raise the Roof

Packard High-Altitude Ignition Cable No. 530-E

When bombers first poked their noses into the stratosphere, the ultimate height of a plane was several thousand feet below where it is today. There were limiting factors and heights above which planes could not go, in spite of straining engines, pressurized cabins and superchargers. One of these factors was the electrical cable that sparked performance—a comparatively minor item, but still mighty important up where the air is rarefied and thin. Under these conditions ordinary cable failed.

In cooperation with the nation's air forces, aircraft industry and airlines, Packard cable engineers developed a high-altitude ignition cable to meet all extremes and conditions. Sheathed in tough synthetic rubber over an inner reinforcing braid, this cable effectively resists sub-zero cold and tropical heat, withstands moisture, overcomes electrical corona. Packard cable has helped raise the roof for high-altitude bombers and fighters.

This tough high-altitude cable is just one of many types that Packard makes for the fighting air forces. There is more Packard cable in the air than any other make.

Till the last shot is fired—
KEEP BUYING BONDS

Packard
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PACKARD ELECTRIC DIVISION
GENERAL MOTORS CORPORATION
WARREN, OHIO

ARMY E NAVY

A second star has been added for continued excellence

Packard cable serves the armed forces on trucks, jeeps, armored cars, planes, aircraft instruments, anti-aircraft gun controls, landing boats, radio equipment.

10,000 A.B.C.

in less than a year

Admitted to membership of Audit Bureau of Circulations June 30, 1944 –10 months after its initial issue.

A RECORD without precedent in its field. Eloquent testimony from industry leaders of the urgent need for a publication devoted wholly and exclusively to the specialized needs of air transportation.

A RECORD of unusual significance because (1) circulation is carefully confined to airlines men, executives of aircraft and parts manufacturers and civilian, military and government authorities concerned with air transport; and because (2) AIR TRANSPORT's subscription price is $5.00 a year in a field where $3.00 is usually top.

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O. M. Mosier, Vice-President, American Airlines, Inc.: "I commend you for the brief, forceful and constructive manner in which you have approached the future program of air transportation."

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William B. Stout, Stout Research Division of Consolidated Aircraft Corp.: "The editorials and very excellent material throughout the magazine express the fundamentals of a policy which may well be of value to an ever-growing industry—aviation!"

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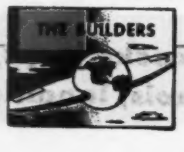
ALL THE FACTS IN THIS BOOKLET



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U. S. Navy's Grumman Hellcat Completes a Mission

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AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

COUNT ON
Curtiss Commandos
FOR TWIN-ENGINE ECONOMY

Lower the cost of air transportation and, at once, you raise the number of people and the kinds of cargo that will fly.

Coupled with such favorable features as its speed, capacity and dependability, the twin-engine economy of the Curtiss Commando will go a long way toward stimulating increased air commerce and consequent revenue for the airlines that operate it.

Ninety percent of domestic air travel is on flights of medium range. Over this range on a basis of block time, payload and direct flying cost, the Curtiss Commando is the most economical aircraft of its type. Curtiss-Wright Corporation, Airplane Division, Buffalo, New York.

COUNT ON *Curtiss-Wright* FOR ACHIEVEMENT IN THE AIR

LOW TEMPERATURES

...and how their embrittling effect on metal parts can be avoided

Today, when choosing a metal for critical aircraft applications, a new factor must be considered...

The effects of intense cold on its properties.

The most common trouble comes, of course, from *brittleness.*

To avoid it, metals need high ductility and toughness, not only at ground-level temperatures but in the sub-zero cold of the sub-stratosphere.

As this ductility and toughness, in turn, must usually be coupled with other properties of strength, hardness, corrosion-resistance, etc., the problem resolves itself into finding a material that combines *all* the desired properties.

This is exactly the reason why the INCO Nickel Alloys are especially useful for parts to withstand sub-zero temperatures. In addition to their strength and resistance to corrosion, these metals exhibit a unique and valuable characteristic: *Instead of becoming brittle they retain their high toughness values as their strength and hardness increase.*

This is in marked contrast to the results observed with many other engineering materials which, while retaining reasonable tensile strength, grow increasingly brittle as the temperature drops.

High Properties at Low Temperatures

The tensile strength of the high-nickel alloys at normal temperatures, for instance, is equal or superior to that of many steels. This strength and hardness actually increase as the temperature skids down into the sub-zero range. (See table below).

The important factor of *freedom from brittleness* is illustrated by the results of Charpy impact tests. Here, the normally high impact strength of nickel at ordinary temperatures actually increases an average of 10% at −110° F. Inconel loses slightly in ductility, but both Monel and "K" Monel retain substantially the same high impact rating.

Non-Magnetic Properties

Three of the high-nickel alloys are non-magnetic at sub-zero temperatures. (See Table).

Consideration of non-magnetic characteristics along with strength and ductility turns the spotlight immediately on "K" Monel. This alloy can be age-hardened and will remain non-magnetic to as low as −150° F. Severe cold work and age hardening do not change its non-magnetic characteristics.

A typical application is in the Sperry Horizon Instrument. Here the *combined* strength, ductility, corrosion-resistance and non-magnetic properties of "K" Monel single it out as the ideal material for long, accurate service.

* * *

For further information regarding the properties and working of INCO Nickel Alloys, write for a copy of the booklet "INCO Nickel Alloys for the Aircraft Industry." A copy is yours for the asking. Address:

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL ST., NEW YORK 5, N. Y.

Magnetic Properties

Material	Magnetic Transformation Temperature (Curie Point) °F at Permeability of 1.02 max.	Permeability at Room Temperature H = 21 ± 1 Oersted	H = 200 Oersted
"K" Monel	minus 150	less than 1.02	1.0015
"S" Monel	minus 70	less than 1.02	1.005
Inconel	minus 40	less than 1.02	1.005
Monel	110-430	25	15
Nickel	680	120	30
Iron	1410	5000+	500

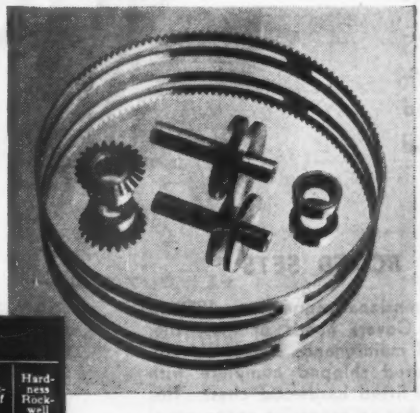
Summary of Effect of Low Temperatures on Nickel and High-Nickel Alloys

Increase with Decreasing Temperature	Remain Unchanged with Decreasing Temperature	Decrease with Decreasing Temperature
Tensile strength Yield strength Proof stress Proportional limit Tensile modulus Torsional modulus Brinell hardness Fatigue life (for a given load) Elongation	Reduction of area Impact strength	Length

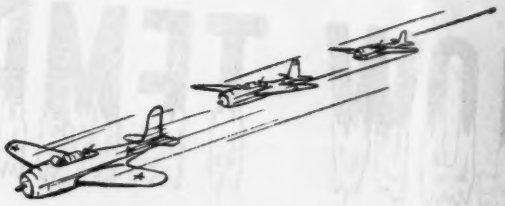
Mechanical Properties at Low Temperatures*

Material	Condition	Temperature °F	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Reduction of Area per cent	Hardness Rockwell C
Monel	Cold-drawn	Room	93,700	103,800	19.0	71.0	19
	Cold drawn	−110	100,850	117,450	21.8	70.2	25
	Cold-drawn	Room†	95,300	103,400	17.3	72.5	21
Nickel	Cold-drawn	Room	97,400	103,400	16.3	66.9	19
	Cold-drawn	−110	101,800	112,300	21.5	60.9	22
	Cold-drawn	Room†	95,750	102,700	16.3	69.2	20
Inconel	Annealed	Room	36,800	93,800	37.3	64.1	82B
	Annealed	−110	42,400	106,450	39.8	64.0	87B
	Annealed	Room†	36,200	93,000	36.5	64.4	82B
	Cold-drawn‡	Room	147,700	152,100	7.0	49.3	31
	Cold-drawn‡	−110	154,900	163,900	9.8	51.2	36
	Cold-drawn‡	Room†	147,400	151,900	7.3	49.3	32
"K" Monel	Cold-drawn, age-hardened	Room	125,900	157,300	15.5	37.4	33
	Cold-drawn, age-hardened	−110	134,600	171,550	17.3	41.1	36
	Cold-drawn, age-hardened	Room†	125,850	157,350	14.8	37.2	33

*Bureau of Standards Report, June 14, 1937
†Cooled to and held at −110° F. for several hours prior to testing at room temperature
‡50 per cent reduction in cross-sectional area by cold drawing



PARTS FOR SPERRY HORIZON INSTRUMENT. Tough, strong, *non-magnetic* "K" Monel assures accuracy...longer life. These parts are machined soft, then heat-treated for maximum strength and hardness.



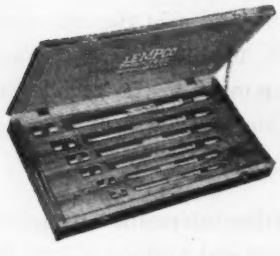
PINPOINT REAMING

The patented Lempco Dual-Spiral Hi-Speed Steel Expansion Reamer is fast, accurate, and economical. 500% greater expansion range, plus the fact that removable blades may be re-sharpened 8 to 10 times, enables one Lempco Dual-Spiral to ream as many different size holes as 6 to 8 conventional expansion reamers. It eliminates honing, and the costly wear on plug gauges caused by abrasive left by honing. It reams smoothly over keyways and split bushings. Extension pilots are available for alignment jobs.

SPECIAL REAMERS DESIGNED TO MEET YOUR NEEDS SEND BLUEPRINTS

2-WAY FLUTES . . .

spiral in opposite directions simultaneously, effecting a clean, shearing action that finish-reams holes mirror-smooth. Equally efficient on any machinable metal or fibrous plastic. Blade segments are removable and economically resharpened. Good delivery.



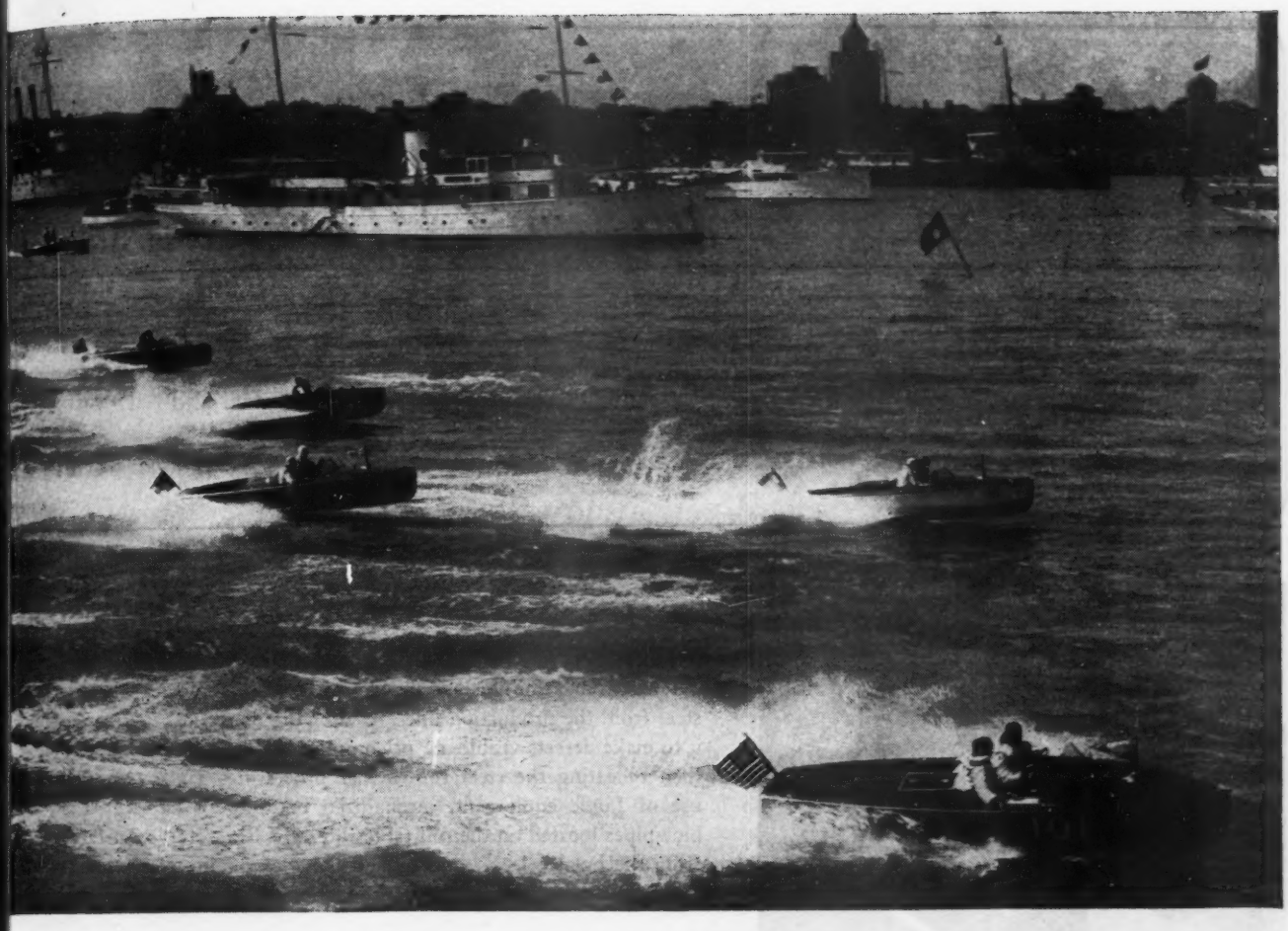
BOXED SETS

with dimensional range from .495" to 1.295". Covers needs of most die, tool and maintenance shops. Set No. JR pictured shipped complete with pilots in fitted hardwood chest. This set of 6 has an expansion range equal to 30 ordinary spiral reamers.

WRITE FOR CATALOG

LEMPCO

5497 DUNHAM ROAD • BEDFORD, OHIO



AWAY AHEAD!

Tobe Leads the Noise Elimination Field

WHAT are the real problems of radio noise interference? Can all man-made spark interference be eliminated? What is a sound source of information for the many problems concerning this entire subject?

The place to get these answers is at Tobe. For Tobe is the acknowledged leader in this field. For 17 years this organization has devoted its resources to the problems of noise elimination.

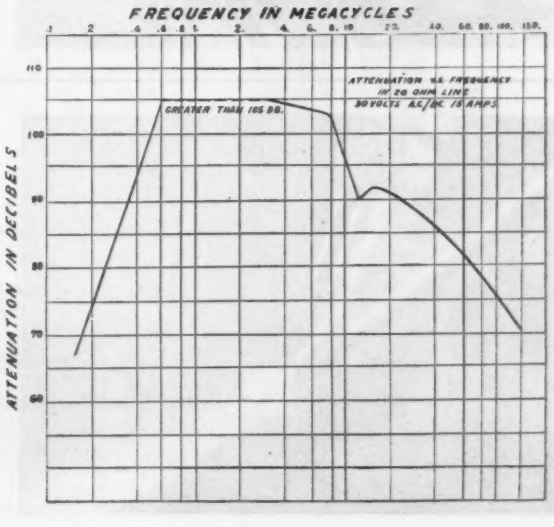
Tobe Filterizing is a copyrighted term describing the Tobe system of blotting-out unwanted "man-made" noise. Why not make use of our valuable experience? Write us about your problems.

TOBE DEUTSCHMANN CORP., CANTON, MASS.

SUPPRESS MAN-MADE RADIO STATIC
TOBE
FILTERIZED

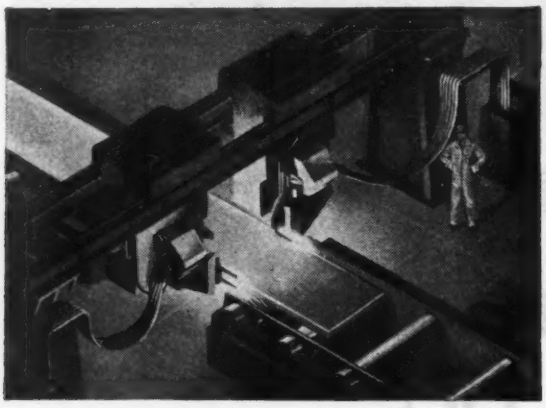
CONTAINER DIMENSIONS

Length	3 1/16"
Width	2 1/8"
Height	2 7/8"
Overall length	5 7/32"

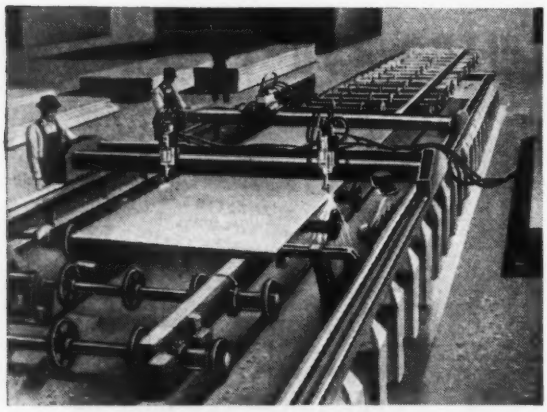

FREQUENCY IN MEGACYCLES
ATTENUATION IN DECIBELS
GREATER THAN 105 DB.
ATTENUATION VS. FREQUENCY IN 20 OHM LINE 30 VOLTS AC/DC 15 AMPS.

LINDE'S METALWORKING METHODS
Help to Speed Production . . . Lower Costs

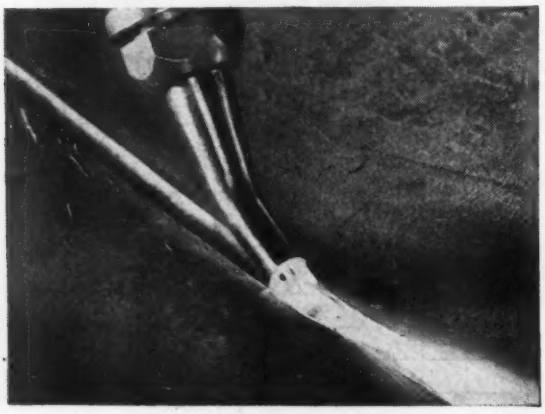
Continuing savings of time, money, and materials result from the use of these Linde-developed methods in the production of steel. There are other Linde methods to help maintain steel-producing equipment and to form, treat, and fabricate steel.



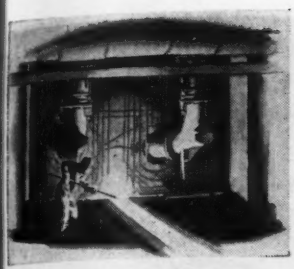
MECHANIZED HOT-SCARFING – The removal of surface defects from semi-finished steel once entailed removing the hot steel from the production line . . . allowing it to cool . . . treating it to make defects visible . . . or chipping out these defects . . . and then reheating the steel for further processing. Today, through use of Linde equipment, mechanized batteries of oxy-acetylene blowpipes located on the roll tables literally "skin" faulty surfaces from the hot steel . . . and higher yields of quality steel are obtained without interruption of production.



MECHANIZED FLAME-CUTTING – For shaping steel in the fabrication of industrial machines and equipment oxy-acetylene cutting is effecting important savings, both in time and in materials. The oxy-acetylene flame quickly and accurately slices through steel in straight lines, circles, or irregular shapes . . . work that otherwise would require massive machines. Linde engineering skill has helped adapt this "knife that never dulls" to high-speed work like the flame-planing of ship steel shown here. In one operation plate edges are trimmed to exact size and beveled like this ⌐ ¬ for welding.



FLAME-GOUGING – Oxy-acetylene flame-gouging is a rapid and economical method of forming U-shaped grooves by removing surface or edge metal from rolled, drawn, forged, or cast steel. Gouging nozzles can be fitted to ordinary blowpipes to quickly remove riser pads from castings, to rough-shape steel and thereby reduce machining time and costs, to prepare plate edges for welding, to remove roots of initial welds in preparation for backing-up welds, to prepare cracked or broken steel parts and castings for welded repair, to remove temporary welds, and to fabricate parts requiring a groove.

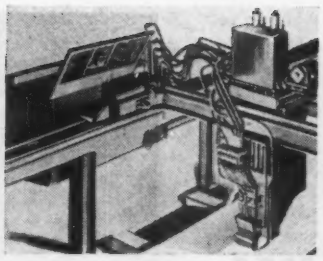


FURNACE-TAPPING

By use of the oxygen lance to clear the tap hole, the opening is quickly made for molten iron or steel to pour from the furnaces.

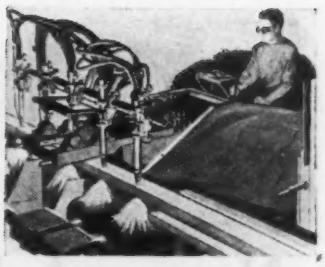
DESEAMING

Where mechanized conditioning of steel is not feasible, or for secondary conditioning, manually operated flame-scarfing equipment is used.



COLD-SCARFING

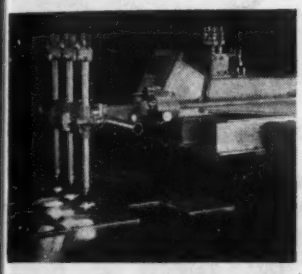
Some special steels, such as slabs of armor plate, are allowed to cool before scarfing by Linde machines that move along the slab.



BILLET-CUTTING

Flame-cutting machines developed by Linde are used in the production line to cut billets and bars to length quickly, several pieces at a time.

Apparatus and Supplies for Every Application of the Oxy-Acetylene Process

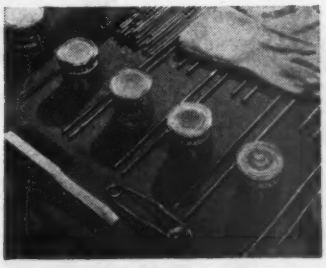


MACHINE APPARATUS

Included in the OXWELD line of apparatus are portable and stationary oxy-acetylene machines for cutting shapes or straight lines; flame-hardening apparatus; bar and billet cut-off machines; automatic welding equipment; and tractor units for plate-edge preparation.

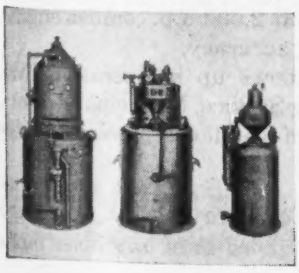
HAND APPARATUS

Oxy-acetylene apparatus which may be ordered from Linde includes oxy-acetylene blowpipes for all welding and heating work; oxy-acetylene cutting blowpipes, cutting attachments, and nozzles; oxy-acetylene descaling and flame-priming equipment. OXWELD apparatus is supplied from Linde offices and warehouses. The PUROX and PREST-O-WELD line, and PREST-O-LITE air-acetylene appliances for soldering and brazing, are distributed by industrial and automotive jobbers.



WELDING RODS AND SUPPLIES

The many kinds and sizes of OXWELD high quality welding rods make it possible to select the one that will give best results on each job. The OXWELD line also includes fluxes, gloves, goggles, lighters, hose, and asbestos paper. Rods and supplies may be ordered from Linde or from automotive and industrial jobbers.



GENERATORS AND MANIFOLDS

OXWELD acetylene generators have maximum generating capacities of from 30 to 9,000 cu. ft. per hour. OXWELD manifolds centralize oxygen and acetylene supply from cylinders.

OXYGEN, ACETYLENE, CARBIDE

A booklet describing use of LINDE oxygen, PREST-O-LITE acetylene, UNION carbide, and OXWELD apparatus in these and other processes will be sent without charge on request. Ask for Form 5268A.

BUY UNITED STATES WAR BONDS AND STAMPS

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

. The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," "Prest-O-Weld," "Haynes Stellite," and "Unionmelt" are trade-marks of Union Carbide and Carbon Corporation or its Units.

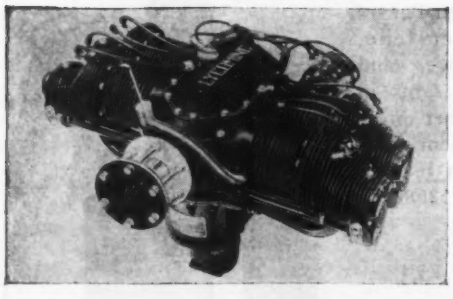
Now ask HIM if the 2700 Lycoming Inspections pay! . . .

There are 338 parts in the Lycoming 65. And approximately 2700 inspections! . . . All known laboratory inspections—including X-Ray and Magnaflux: Every *practical* inspection, including test runs and teardowns for each individual engine. Altogether—an average of 8 inspections per part.

Too much care, you say? We think not. Because a life can depend as much on a 65 h.p. Lycoming as on a giant 2,000 h.p. combat engine. They are built with just as much care and accuracy.

And that meticulous production-care shows up in operation. Mr. John A. Clinch, owner of the Clinch Flying Service, Municipal Airport, North Platte, Nebraska, who has a fleet of 15 planes powered by the 65 h.p. Lycoming, says . . .

"Our records prove the Lycoming 65 can stay at the job longer and deliver a more economical operation record than any other make of engine."



LYCOMING, MODEL O-145, developing 65 h.p. at 2550 rpm.

Weight — only 165 lbs., *7-10% less than competitive engines.*

Gas consumption — 2½-3 gals. per hour, *19-32% saving over competitive engines.*

Among aircraft *"Powered by Lycoming"* are: Aeronca, Beechcraft, Bellanca, Boeing, Cessna, Curtiss, Luscombe, Piper, Spartan, Stinson, Taylorcraft, Vultee.

Let Lycoming power *your* aircraft.

LYCOMING

AIRCRAFT ENGINES . . . 55-300 H. P.

AN AVCO PRODUCT

Lycoming Division
The Aviation Corporation
Dept. D-5, Williamsport, Pa.

POWERED BY LYCOMING — THE ENGINE WITH A PROVEN PAST AND A SURE FUTURE

It's Easy to See Why They're Better...

's a funny thing about wrenches. You use them all ay long. They're the most important tools in your t. You know which ones do the job best—which es last the longest. But chances are you never op to think why.

hen you take a good look at a Bonney Wrench, s so easy to see why it's better.

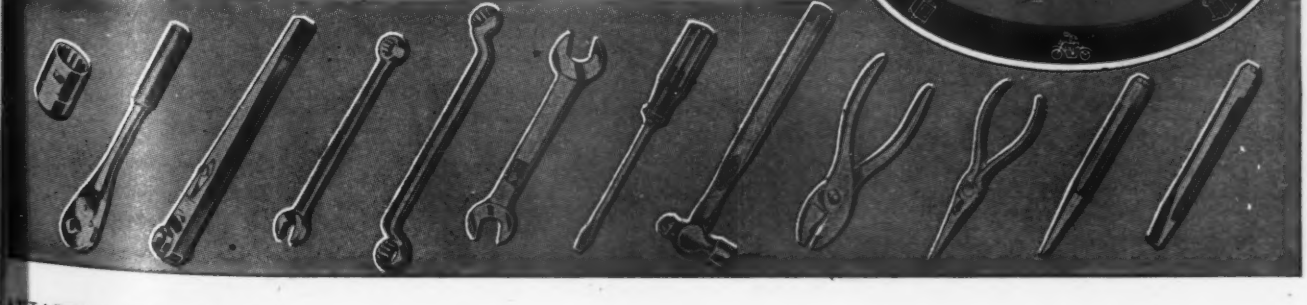
e openings in a Bonney Engineers' Wrench, for stance, aren't just milled—they're *precision-illed*. They fit the nut exactly—no slipping, no rcing. The jaws are tapered to give you more turn-g room. They're reinforced with extra metal at the points of strain. The handles are rounded for an easy, comfortable grip. And something you can't see—to make Bonney Wrenches the strongest and toughest on the market, each one is given our special pyrometer-controlled heat treatment.

We put a lot into Bonney Wrenches because we want you to get a lot out of them.

If you do not already have a Bonney Engineers' Wrench Set, ask your nearby Bonney distributor or jobber to order one for you now. All Bonney Tools are sold exclusively through distributors and jobbers from coast to coast.

NNEY FORGE & TOOL WORKS · 711 N. MEADOW ST. · ALLENTOWN, PA.

In Canada: Gray-Bonney Tool Company, Ltd., St. Clarens & Royce Aves., Toronto



BETTER PERFORMANCE AND DEPENDABILITY

FOR EVERY AIRCRAFT ENGIN

The ultimate criterion in aircraft spark plugs is their ability to yield better performance and dependability regardless of operating conditions.

Champion Ceramic Aircraft Spark Plugs have established new high standards of performance and dependability, long life and minimum service problems in engines of every size and type on active duty with our Air Forces. This is the fruit of over 35 years devoted *exclusively* to the production of better, more dependable spark plugs.

This outstanding success in military aircraft proves that Champion through specialization provides a perfect solution for those who seek the ultimate in spark plug performance. Use Champions and fly with confidence. Champion Spark Plug Company, Toledo 1, Ohio.

C26—Unshielded

Buy War Bonds

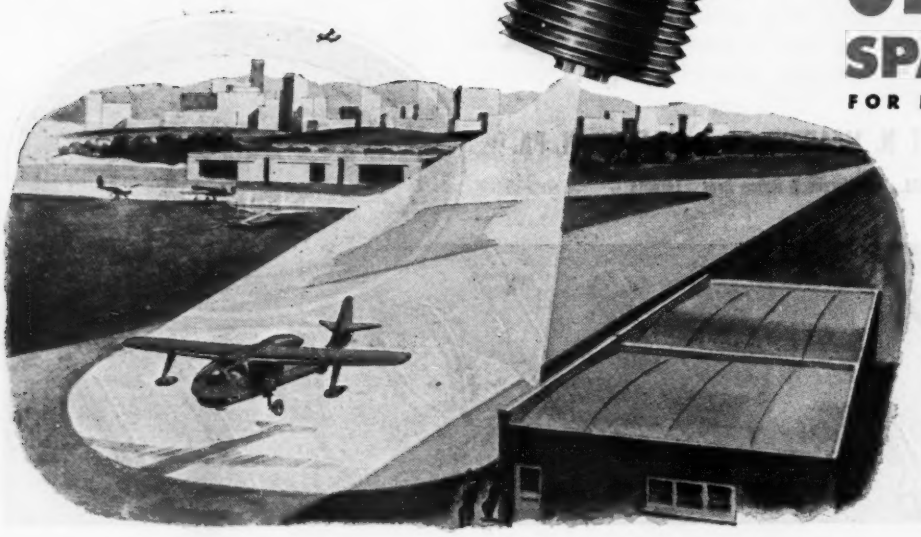
More Than Before

DEPENDABLE

CHAMPION

SPARK PLUGS

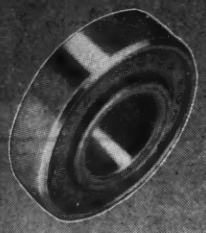
FOR EVERY AIRCRAFT ENGINE

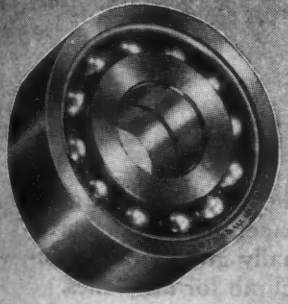


C34S—Shielded

SCHATZ
BALL BEARINGS

FOR EVERY TYPE OF INSTALLATION





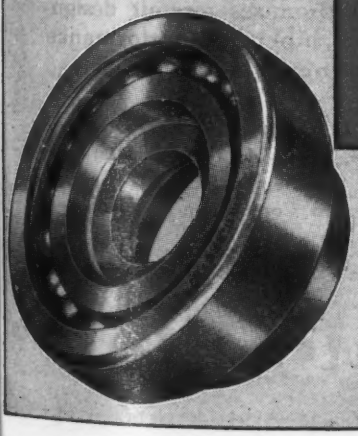
SCHATZ MANUFACTURES BALL BEARINGS FOR EVERY PURPOSE AND ANY PRODUCT

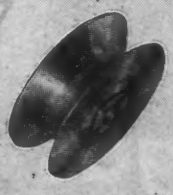
STANDARD TYPE OR MADE TO YOUR SPECIFICATIONS

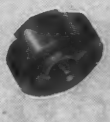
THE SCHATZ MANUFACTURING CO.
POUGHKEEPSIE, N. Y.

REPRESENTATIVES LOCATED AT

Detroit: 2640 Book Tower—26 • Cleveland: 402 Swetland Building—15
Chicago: 902 S. Wabash Ave.—5 • Los Angeles: 5410 Wilshire Blvd.—36

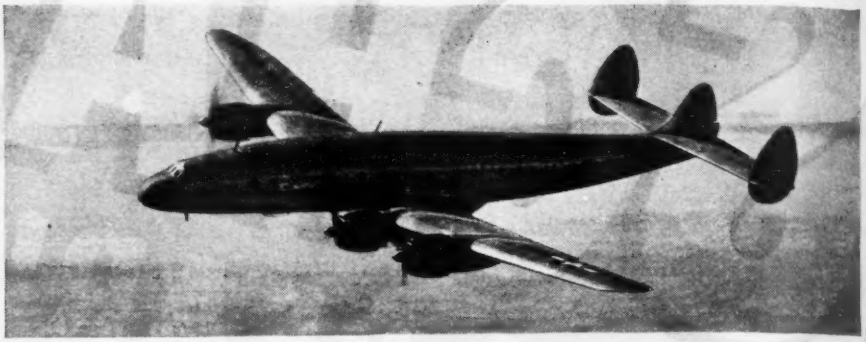




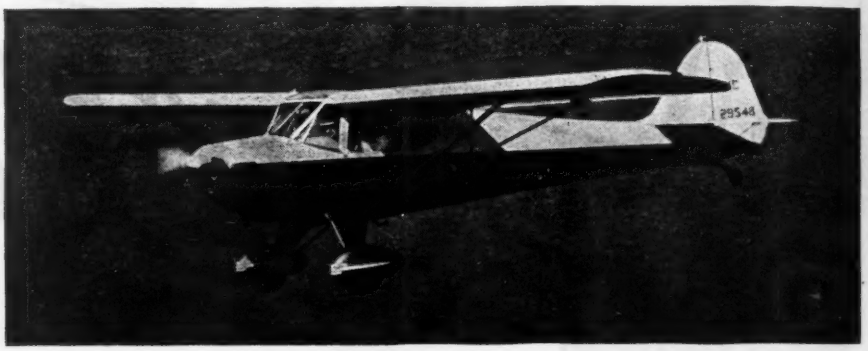


Greater Flight Range . . . Bigger Pay-Loads . . . Quicker Take-Off

For Essential Aircraft Now . . .



After Victory— for All Planes!



Flying Horsepower From New Mobilgas

☛ Today Uncle Sam's war eagles and America's essential civilian aircraft are getting sensational new power from gasoline—Flying Horsepower!

☛ Flying Horsepower is the result of 12 years' Socony-Vacuum research in catalytic cracking and multiple developments, climaxed by the famous TCC Process and Magic Bead Catalyst.

☛ Fuel with this super power is flowing from 19 great Socony-Vacuum catalytic cracking units, representing a total investment in new refining facilities and equipment of over $90,000,000.

☛ Soon as war ends, full capacity of these giant refineries will swing to peacetime production... to make possible sensationally greater range, carrying-power, take-off and climb for *all* planes.

☛ Socony-Vacuum's continued development of Flying Horsepower promises aircraft designers, builders, operators super fuel performance that will meet every future flight need.

SOCONY-VACUUM OIL COMPANY, INCORPORATED
26 Broadway, New York 4, New York, and Affiliates: Magnolia Petroleum Company, General Petroleum Corporation of California.

Mobilgas Mobilgas AIRCRAFT Mobiloil Aero RED **Mobiloil**

BATTLE PASSENGERS..

They, Too, Depend On Douglas

Douglas
AIRCRAFT

DOUGLAS EQUIPPED AIRLINES: All American Aviation — American Airlines — Braniff Airways — Chicago & Southern Air Lines — Colonial Airlines — Continental Air Lines — Delta Air Corporation — Eastern Air Lines — Hawaiian Airlines — Inland Air Lines — Mid-Continent Airlines — Northeast Airlines — Northwest Airlines — Pan American Airways Pennsylvania-Central Airlines — TWA — United Air Lines — Western Air Lines — A. B. Aerotransport (Sweden) — Aer Lingus (Ireland) — Aerovias Braniff, S. A. (Mexico) — Aerovias de Guatemala, S. A. — American Airlines of Mexico — Australian National Airlines — Avianca (Colombia) — BOAC (British Overseas Airways) — Canadian Pacific Airlines — China National Airways — Cia. Mexicana de Aviación — Cia. Nacional Cubana de Aviación, S. A. — Cruzeiro do Sul (Brazil) — Indian National Airways — K.L.M. (Royal Dutch Airlines) — K.N.I.L.M. (Dutch East Indies) — IBERIA (Spain) — Panair do Brazil — Panagra (Pan American-Grace Airways) — PLUNA (Uruguay) — SABENA (Belgian Congo) — Swissair (Switzerland) TACA (Central America) — UMCA (Central America).

(Continued on page 3, column
Superfort Fights Off 79 Zeros, Downs 7, Doesn't Get a Scratch
A B-29 BASE IN
CHINA, Oct. 31. —
Japanese fighter planes ganged
on a single American B-29 Super-
fortress over their own home is-
lands recently and not only failed
to so much as scratch it but had
seven of their own planes shot
down and two damaged by the
bomber's gunners, interrogation
officers disclosed today.
bomber, reported the gunnery sys-
tem functioned perfectly and the
gunners co-ordinated their fire so
well that they put a metal "fence"
around the besieged Superfortress.
IT'S ONE OF THE
Biggest Electrical Stories
OF THE WAR

. . . and here's how the integrated G-E armament system provides a tremendous increase in firepower with no increase in guns.

It is not that the Jap-blasting B-29 bristles with more guns. It doesn't—other bombers have carried as many.

The unprecedented combat stamina of the B-29 is due to its *deadlier* fire-power. Deadlier because of its increased accuracy. Deadlier because it makes possible a more devastating concentration of fire *in any area*. Deadlier because it gives gunners greater comfort and safety.

The B-29 carries something entirely new in aircraft armament—the first remote-control system and the first completely integrated armament system to be applied to any production aircraft.

Begun in 1942

In response to the urgent call, early in 1940, for a power-operated turret, G.E. applied its newly developed amplidyne and its aircraft experience to work out an electrical system for locally controlled turrets.

Then, beginning in 1942, G.E. developed its new remote-control system for the B-29 and other new planes. Utilizing G-E amplidynes, selsyns, dynamotors, as well as G-E computers, turrets, and other equipment, these completely integrated systems are now also being built in enormous quantities.

Many Advantages

By providing extremely accurate, *remote* control of gunfire, the new G-E system has made it possible to locate sighting stations where they give gunners greater visibility, physical comfort, and armor protection. It has facilitated the placing of gunners in pressurized areas, and put them where noise and vibration are markedly less. All of these factors contribute much to the combat efficiency of gunners.

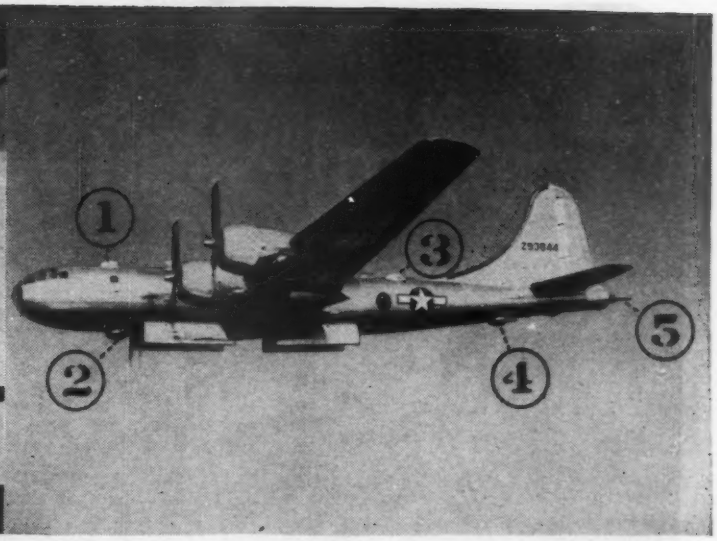
In addition, separation of sighting station from turret has resulted in less drag and better aerodynamic design. Highly important, too, the total weight of the new armament system is less than that of locally controlled armament now in use.

We at G.E. are proud of the part this new gunfire-control system is playing to hasten V-Day. We are proud of it, too, as an outstanding example of how, in peacetime, G-E "can do" will make planes more economical, and easier and safer to fly. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

674-31-8872

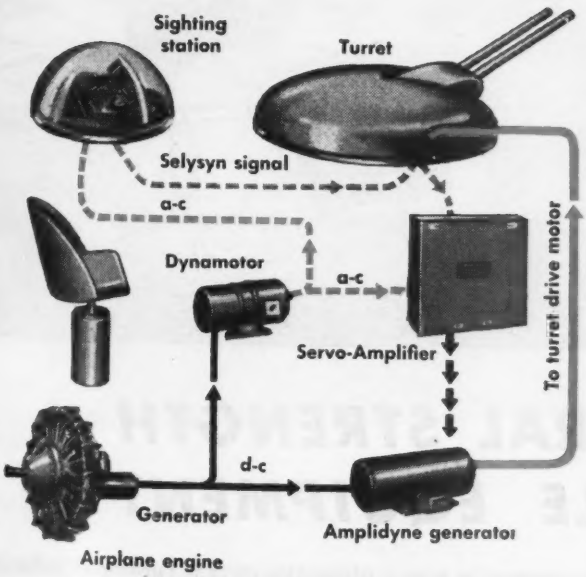
Buy all the BONDS you can—*and keep all you buy*



● (opposite page) The tail turret of the B-29 mounts a 20-mm cannon flanked by two 50-caliber machine guns. All are controlled electrically from the compartment above the turret.

● (left) Rear top turret of the Superfortress with two 50-caliber machine guns. Forward of the turret is the sighting station from which these guns are controlled.

● (above) The five turrets on the B-29 are so located that several guns can be concentrated in any direction.



IT'S A SYSTEM!

This diagram shows, simply, how the system works in controlling guns in elevation. Another amplidyne and set of position-indicating devices are used to provide similar control in azimuth.

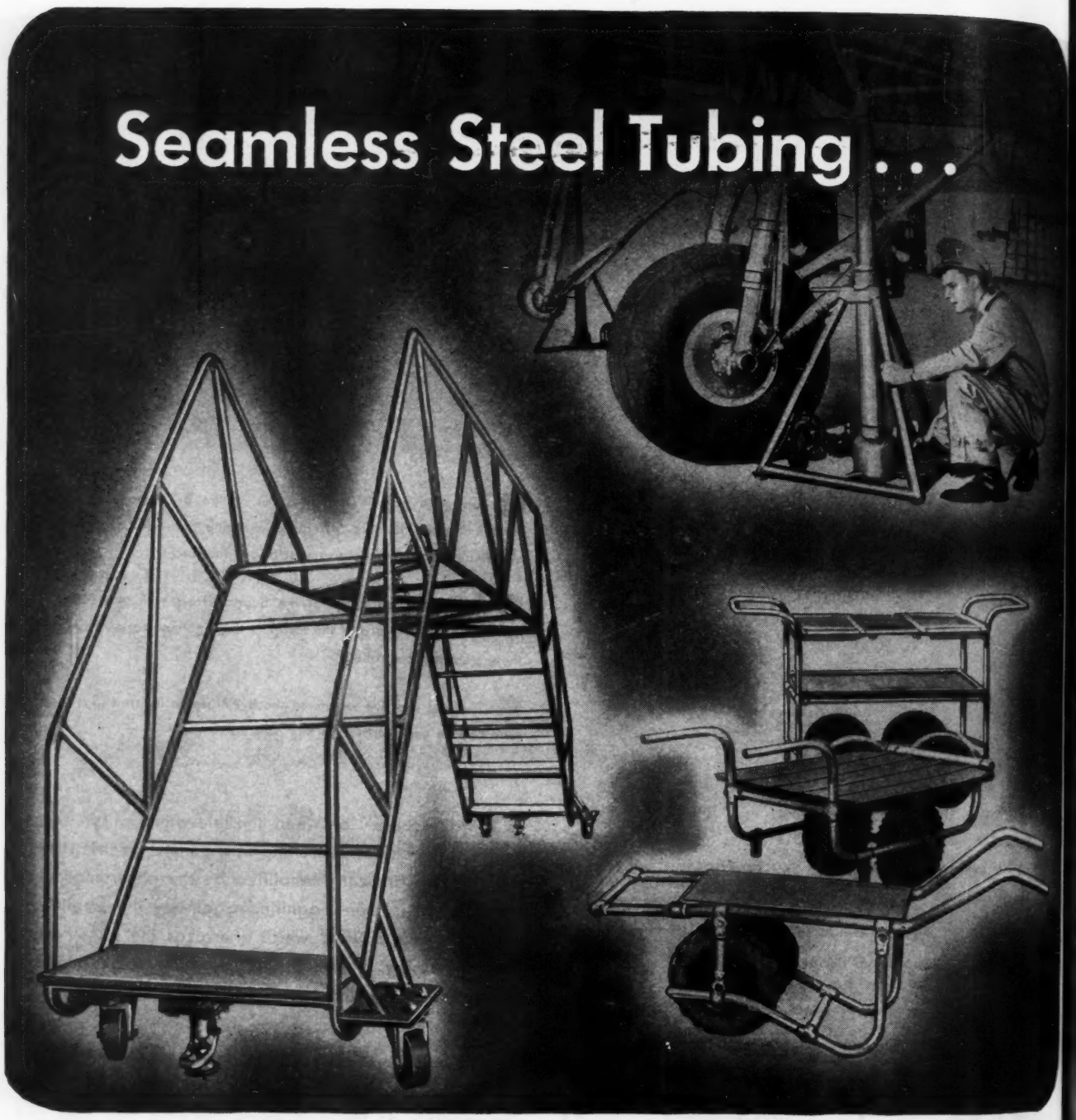
Assume the gunner raises his sight. Immediately, there is a "difference" between the elevation selsyn transmitter and receiver, resulting in a minute electric signal. This signal is instantly amplified by the electronic servo-amplifier. It is then magnified again by the amplidyne into "working power" which energizes the turret drive motor, causing it to turn. As the guns come into the desired position, the signal fades out, and the motor stops.

Although there are several electrical "steps" involved, the response of the guns is practically instantaneous. So smoothly do the guns follow the sight that guns and gunner seem one.

Other G-E engineered systems include d-c and a-c power supply equipment, engine temperature control, high-tension ignition, automatic cowl-flap positioning, and the electric-gyro automatic pilot.

PRECISION PRODUCTS AND ENGINEERED SYSTEMS FOR AIRCRAFT

Seamless Steel Tubing . . .



PUTS STRUCTURAL STRENGTH INTO MOVABLE EQUIPMENT

Strength and light weight make seamless steel tubing a preferred material for numerous pieces of movable equipment used in factories, service stations, and overhaul shops. The same qualities are of primary importance in many other structures. Tubing supplies them, and offers a wide range of diameters, wall thicknesses, and mechanical properties. Also, tubular structures are easy to fabricate and simple to service or repair.

Michigan welcomes inquiries about the availability of seamless steel tubing for all proposed structural uses.

MICHIGAN TUBING

MICHIGAN SEAMLESS TUBE COMPANY

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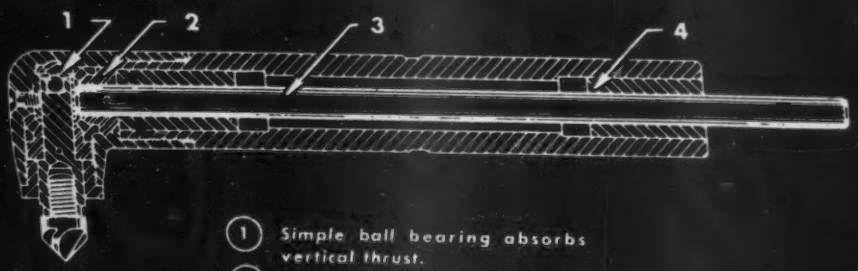
ARMY E

SCHRILLO CRAFTSMANSHIP

. . . at no added cost!



1. Simple ball bearing absorbs vertical thrust.
2. Alloy steel generated gears transmit the required r. p. m. quietly, efficiently.
3. Alloy steel shaft hardened and ground to assure long life under continual use and abuse.
4. Shaft bearings are self-lubricated.

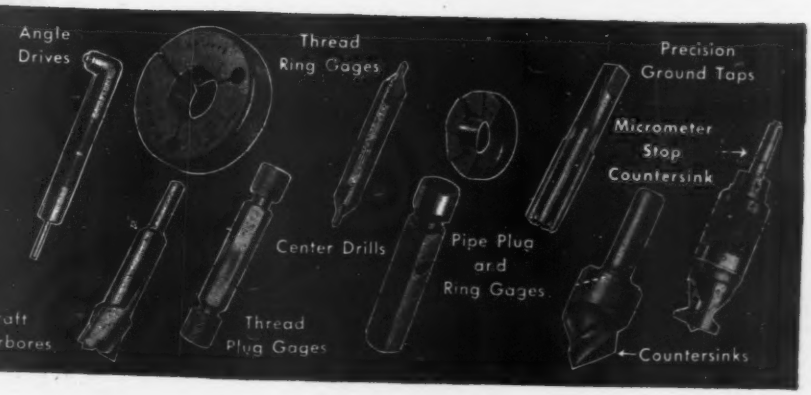
The Schrillo Angle Drive has been developed and introduced for efficient and dependable usage in relatively inaccessible, "out of the way" places common to aircraft manufacture and maintenance. The assembly and all of its component parts are typical examples of Schrillo Craftsmanship featuring the finest of materials coupled with superior design and workmanship. This new development in the Schrillo line of precision tools is consistent with the character and quality of its previous introductions. Priced at only $16.00, without cutter, it will be maintained by the factory in first class working condition at a nominal charge. Immediate delivery out of stock. A complete stock of cutters* is also available. Order by the Tool Number: 1290 B.

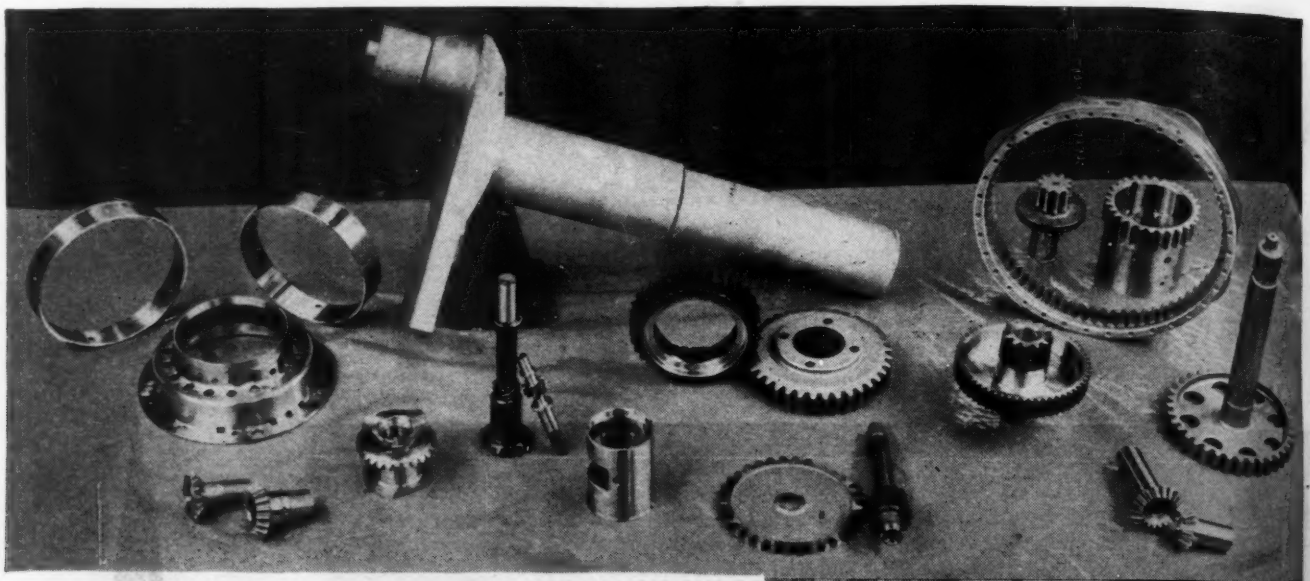
*We solicit your inquiries on special cutting tools.

Overall length, 7⅛ inches. Height, 1⅛ inches. ¼-28 or 10-32 threaded drive. (Specify)

SCHRILLO

LOS ANGELES CALIFORNIA





These carburized parts for the Jacobs 450-hp aircraft engine show some of the heat-treating problems which can be simplified when Homo Methods of carburizing and tempering are used. In the ring gears, distortion-prevention is the main consideration; in the clusters, uniform case is vital; in the crank, a principal problem is depth of case; in the liners, maximum hardness is required. And, always, smooth surface is obtained.

LOW-REJECT Heat-Treating By The 3 HOMO METHODS

In planning their production of trainer-plane engines at Plant Two, the Jacobs Aircraft Engine Co. of Pottstown, Pa. deliberately set out to hold rejects down to a record-making "low".

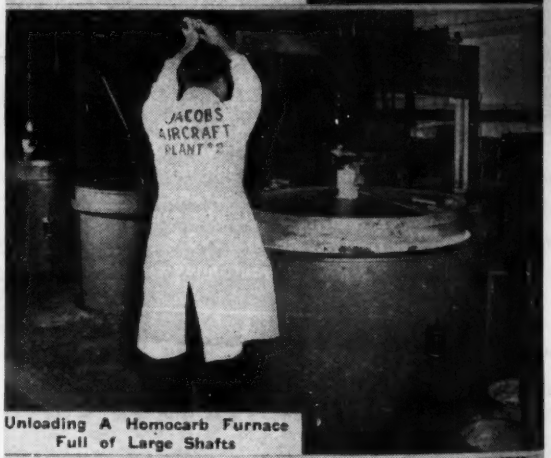
Production records and equipments in other plants were investigated, and when Jacobs finally settled on a certain way of performing an operation, they knew in advance what results to expect.

So, there has been little surprise over the performance of the Homo Method equipments for carburizing, nitriding and tempering; but the results definitely speeded up our country's supply of trainer-plane engines, at a time when it can be said without exaggeration that these engines were desperately scarce. For the engine parts entrusted to Homo Methods are heat-treated exactly as specified; heat-treatment runs for days at a time, with tens of thousands of parts handled without a reject. In the Homo Nitriding Furnace, no piece has ever been rejected. And the 100% inspection is particularly severe, because Jacobs stresses the long service which engines give before repairs are necessary.

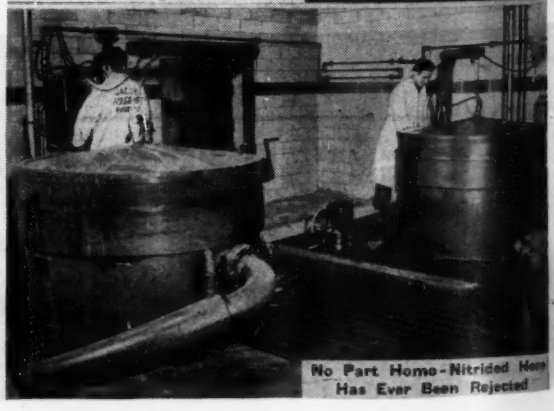
The Homo Methods are described in detail, with many pictures, in our various Catalogs, sent on request. For Homo Carburizing, ask for Cat. T-623; for Nitriding, Cat. T-624; for Tempering, Cat. T-625.

depends on me!
A Slogan For Every American

Homo Tempering Furnaces Being Unloaded



Unloading A Homocarb Furnace Full of Large Shafts



No Part Homo-Nitrided Here Has Ever Been Rejected

LEEDS & NORTHRUP COMPANY
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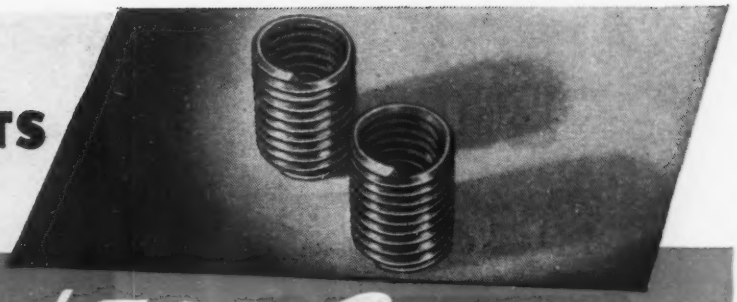
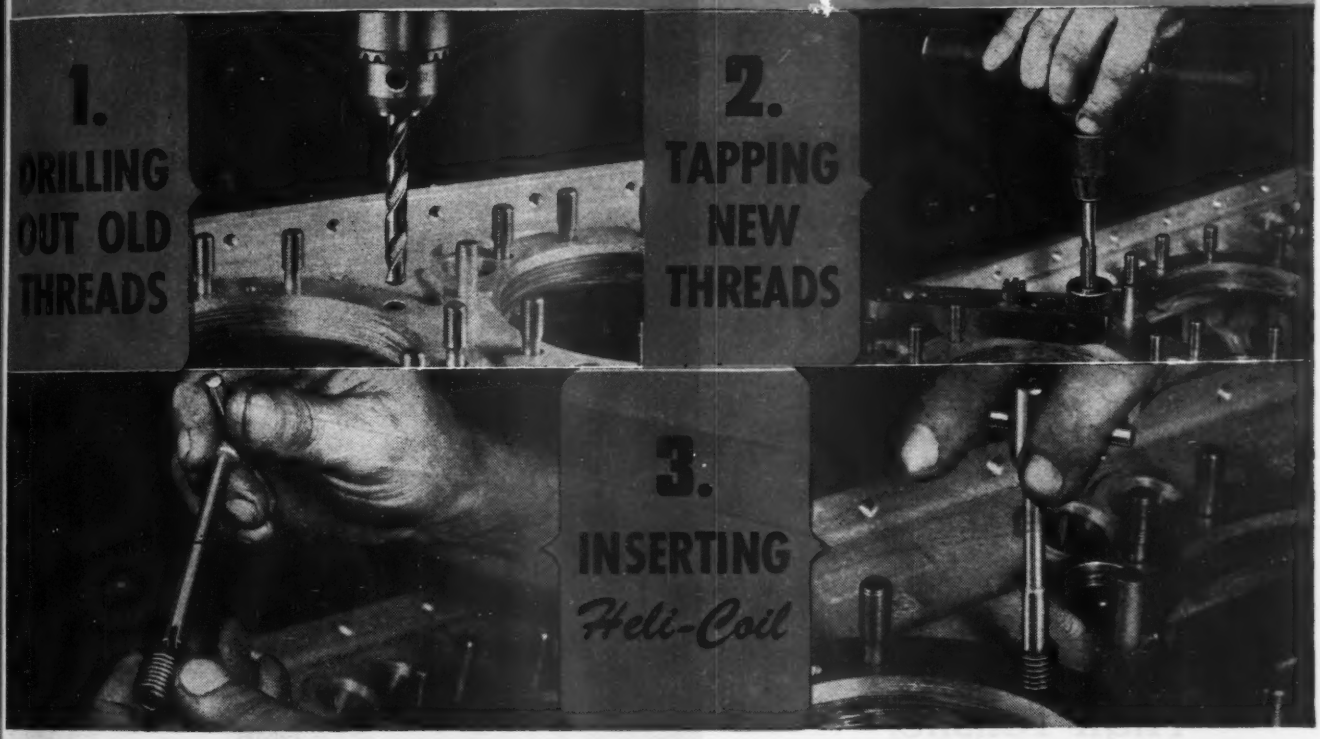
Jrl Ad T-620(18)

HOW *Heli-Coil* INSERTS



Salvage a $500 Casting

IN THREE SIMPLE STEPS!



"Heli-Coil" Inserts restore to correct size, holes that have been accidentally tapped too large. And they do it simply, accurately, economically. They eliminate the need for oversize screws or studs—time-consuming fitting of solid bushings—or the complete scrapping of the casting!

At the Syracuse, N. Y., plant of Aircooled Motors Corporation, for example, "Heli-Coil" Inserts are used to salvage aluminum alloy helicopter crankcase castings valued at $500—as well as in intermediate and timing gear case magnesium castings. Formerly, even when a casting had only one hole tapped oversize, it was necessary to scrap it because of the rigid production standards required. Today, "Heli-Coil" Inserts eliminate this waste!

"Heli-Coil" Inserts are precision-shaped helical coils of stainless steel or phosphor bronze wire, which engage screw threads of the American National System. In addition to their many applications in salvage, maintenance and field servicing, "Heli-Coil" Inserts are widely used in original installations in aluminum and other light metal parts. These inserts provide a hard, anti-friction, protective lining for tapped threads in these softer metals . . . preventing thread stripping, seizing and galling. Write today for complete engineering information.

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AIRCRAFT SCREW PRODUCTS COMPANY, INC.
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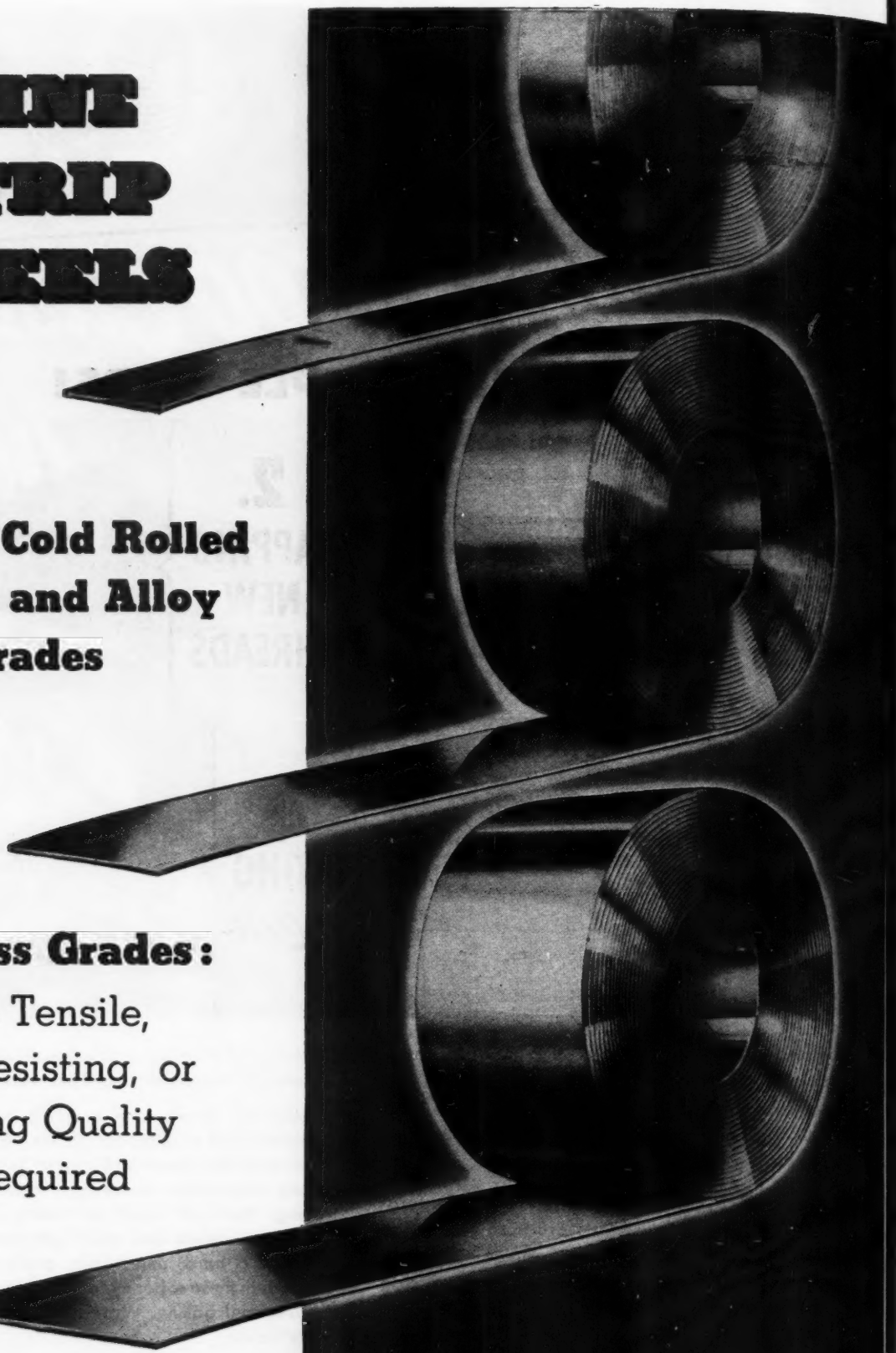
FINE STRIP STEELS



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Stainless Grades:
High Tensile,
Heat Resisting, or
Drawing Quality
as required

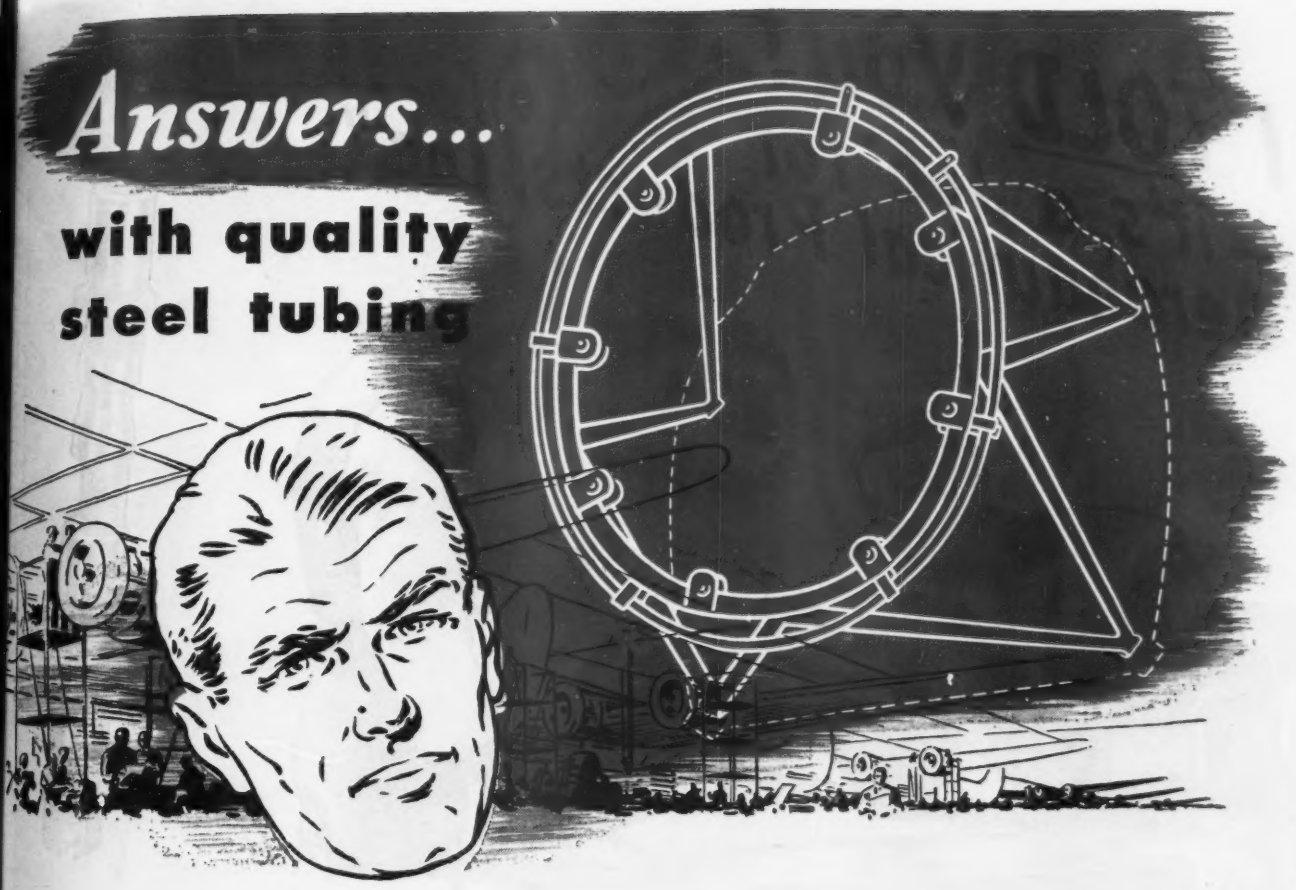
The Name and the Products are

Superior

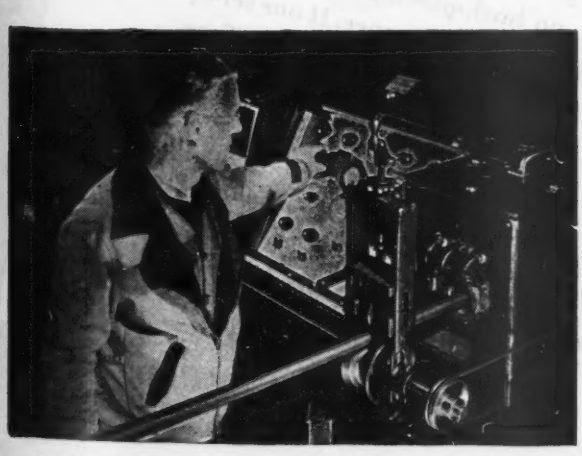
Superior Steel
CORPORATION

Answers...

with quality steel tubing



If you could check at a glance all of the wartime production and structural problems on, say, aircraft engine mounts—or in finding general production short cuts — or in adding superiority to fighting "front" equipment — you'd likely be surprised at the number of "answers" which have been found in steel tubing. Steel tubing offers "strength-weight" advantages in more ways than ever before—a fact revealed in the ever-widening variety of demands on OSTUCO's production.



The "magnetic inspector" — typical of the many machines and operations which constantly "keep an eye" on quality at OSTUCO.

OSTUCO recognizes the tremendous benefits quality steel tubing can offer its customers both structurally—and production-wise. That's why OSTUCO checks quality in every operation. For example, on this page is shown the magnetic inspector which separates analyses and shows up cracks, laps, small cuts and other defects. Dependable *delivery* of quality through the years has earned for OSTUCO an enviable record of low rejects—an enviable reputation for workability and adaptability on the production line.

Are you planning postwar superiority in your field? Why not check with the OSTUCO engineers to see how OSTUCO steel tubing can contribute to that superiority. Simply contact the sales office nearest you:

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CLEVELAND 14, OHIO.....1328 Citizens' Bldg.
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LOS ANGELES, CALIF.....Suite 200-170 So. Beverly Drive, Beverly Hills, California
MINNEAPOLIS 2, MINN.....402 Thorpe Bldg.
MOLINE, ILLINOIS.....225 Fifth Ave. Bldg.
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WHEN your machining specifications say "Tolerance .0005," to us it means five ten-thousandths of an inch, and not a whisper more, or less. Tolerances like these, and much finer, call for experience, skill and machinery of vast proportion. So, if YOUR post-war assemblies require precision machining in volume, right from engineering through to the final inspection, *it's a job for Aeronautical Products, Inc.!* Here in one *complete* organization is everything your job needs. Controlled responsibility . . . no buck-passing. You get your answers straight from the shoulder and backed with performance. If our set-up sounds good to YOU, ask your secretary to write our Executive Sales Offices, Detroit, for an impressive list of plant equipment and *complete* facilities.

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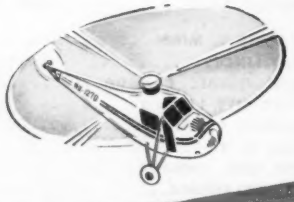

● *THE SUCCESS of The Aeronautical Products, Inc. Helicopter, designed and built by our own craftsmen, promises new accomplishments in the post-war age of flight!*

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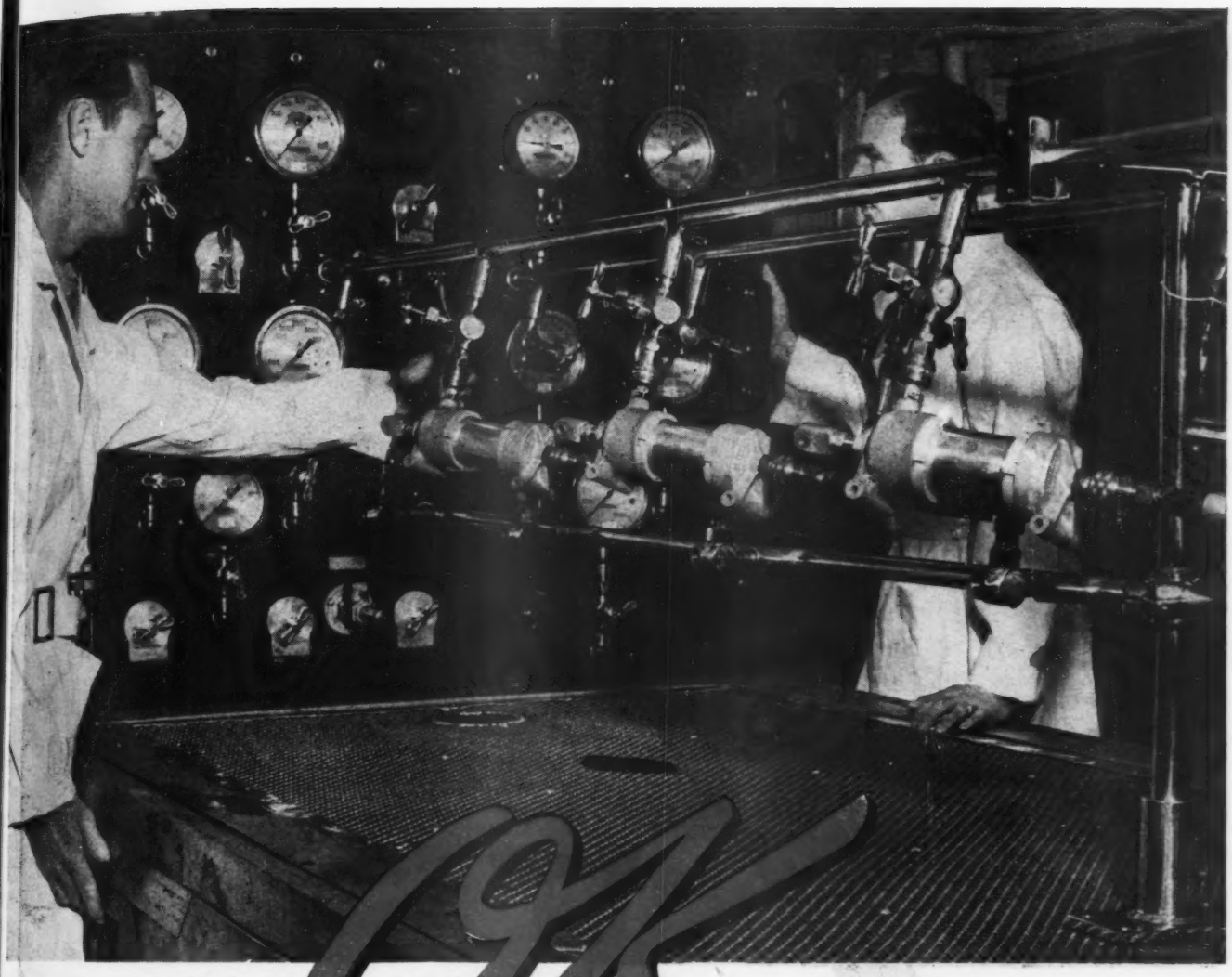

O.K.—says this

HYDRAULIC TEST LABORATORY

Interstate designed it for Interstate: to make scientifically certain that every hydraulic unit produced in this plant is 100% O.K. The Hydraulic Test Bench pictured above has many unique features. For instance:

It can test many units simultaneously. It can test them under a great variety of conditions. It has a testing capacity up to 3,000 lbs.

In addition, it completely filters hydraulic fluid—through a two-way filter mechanism. The first filter reduces all foreign particles down to 10 microns; the second filter reduces them down to 2½ microns.

This Hydraulic Test Bench is another proof of the engineering skill and production accuracy that go into every Interstate precision unit.

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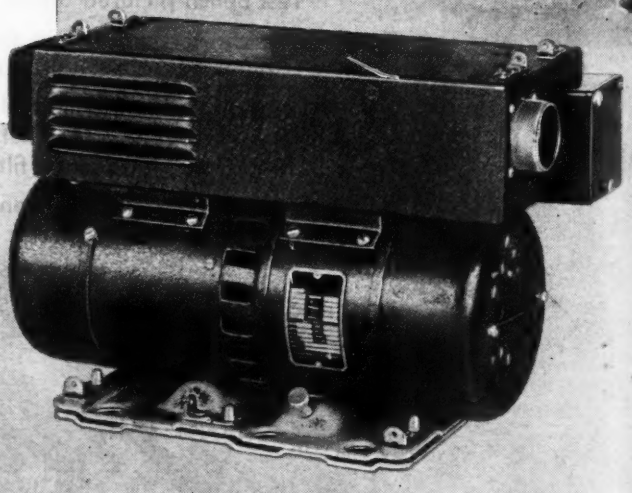
» LELAND is more than a motor name plate. LELAND stands for *Creative Electrical Engineering*—the technical ingenuity to design and build a power unit for your specific application to deliver peak efficiency and performance.

This inverter, for example, was built to meet a special need. The problems involved and their solution point up LELAND'S special skill in *Creative Electrical Engineering*. We invite you to consult with us.



THE Leland *ELECTRIC COMPANY*

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AIRBORNE POWER INVERTER—D.C. drive from aircraft electrical system, high frequency A.C. output up to 2,500 volt amperes used as power supply for electronic equipment.

REDEDICATION

An Obligation to Our Fighting Men

During the last few weeks we have been forcibly reminded that so long as we still are fighting either of our major foes, first claim upon the productive resources of the United States—its manpower, materials, utilities, and industrial facilities—must be the production and delivery of munitions and war supplies. All other claims are secondary. No responsible citizen would have it otherwise. For in this war even more is at stake than our existence as a Nation. We dare not forget that we are engaged in a struggle that challenges the fundamental values upon which our civilization has been built.

It is not easy to list the values that we are fighting to uphold. They have been clothed in a variety of shapes over the centuries. They will assume new forms in the years ahead. But they have an inner consistency that free men the world over can feel and recognize: the right of the commoner against the noble, the right of the individual against the state, the right of trial by jury, the right to vote, the right to an education, the right to freedom of speech and worship, the right to work in a sphere of one's own choosing, the dignity and the equality of the individual under the law—these are our cultural heritage, painfully won and often precariously held over the ages, always to be rewon, redefined and buttressed by each succeeding generation of men.

The preservation of this vital core of value, and its transmission to our sons and daughters depends upon our victory in this struggle. So those things which are essential to victory must come first. And since the production of war munitions in overwhelming volume and quality can hasten that victory and save countless lives of our fighting men, no effort that will contribute to this end should be regarded by us as a sacrifice.

☆ ☆ ☆

The present is no time for self-congratulation upon our achievements either in the theatres of battle or of production. The mounting casualty lists should suffice to curdle the savor of any such indulgence. The most that can be said in reasonable taste and good conscience is that performance in both fields is such as to warrant our firm confidence that we can carry to successful completion the tasks that remain to be done.

Nor is there profit in even observing, much less deploring, that the tasks ahead are more formidable than those which were defined for us a few short months ago. Then, all of us—military leaders, government officials, workers, and business men—were riding a crest of optimism as to an early end of the war in Europe and as to the character and dimension of the war against Japan. Already we had begun to turn anxiously toward the problems of reconversion which then seemed so near at hand. Schedules for war production, based upon the best available estimates of need, called for a 5 billion dollar reduction from 1944 performance, even though we might have to continue a two-theatre war, and for a 40 percent reduction in the event of an early victory in Europe.

Today, those forward estimates have been revised sharply upward. That is true both of the 1945 requirements to meet the needs of a two-theatre war, and of requirements for the Pacific war once the European phase is ended. For this upward revision four chief reasons are responsible:

1. European battle experience has shown markedly greater use of expendable munitions than was provided in the formulae upon which our original production schedules were calculated: the result has been a depletion of inventories on a scale that would become dangerous if allowed to continue.
2. Experience has also demonstrated the need for new types of weapons or increased complements of some existing types to match new enemy equipment or tactics.
3. A less easy optimism as to the early ending of the European war has given rise to a growing disinclination to gamble on the approximate date.
4. An increasing conviction prevails that the war against Japan may require ground-army operations on the Asiatic mainland on a scale greater than originally premised.

But if these changes in the fortunes and outlook of war have raised our estimates of military requirements, may not subsequent favorable changes in the military situation cause them again to be revised downward? It is entirely possible. But our military men have learned that they cannot safely discount what *might desirably happen* as something that *will happen*. Those working on the production front also must learn that lesson. Fortunately, the record shows that we have been able to maintain a war production almost equal to that of the rest of the world combined, even while we produced for civilian use on a scale that has been large even by our

ANOTHER EXAMPLE OF

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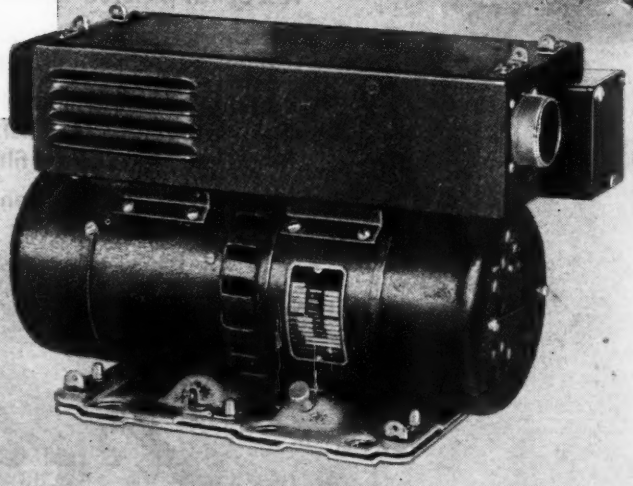

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3. A less easy optimism as to the early ending of the European war has given rise to a growing disinclination to gamble on the approximate date.
4. An increasing conviction prevails that the war against Japan may require ground-army operations on the Asiatic mainland on a scale greater than originally premised.

But if these changes in the fortunes and outlook of war have raised our estimates of military requirements, may not subsequent favorable changes in the military situation cause them again to be revised downward? It is entirely possible. But our military men have learned that they cannot safely discount what *might desirably happen* as something that *will happen*. Those working on the production front also must learn that lesson. Fortunately, the record shows that we have been able to maintain a war production almost equal to that of the rest of the world combined, even while we produced for civilian use on a scale that has been large even by our

own pre-war standards. So we have ample margin to whip whatever war job may be required of us. As now defined, the task will not be easy. But it *can* and *will* be done.

☆ ☆ ☆

What, then, is the production task with which we are charged? Our 1945 production for the two-theatre war now calls for the substantial maintenance of the over-all levels reached in the latter months of 1944. But there is a shift of emphasis. Almost half of the programs for specific equipment items are declining. A few are scheduled to hold level. About 45 percent are scheduled to rise sharply. That means that workers and facilities must be shifted to man the expanding programs. At the same time the armed services are calling for many more men than can be supplied from those who become newly eligible to the 18 year old age group. That means further drafts upon war workers. It means also replacements for them when they are taken from the expanding programs. Finally, events demand that we produce as much as possible of many items during the first half of 1945.

Our task, then, is one of intensified effort for the immediate future, with multiple readjustments at a stage when adjustments are hard to make. Materials for which demand was easing as pipe-lines were being drained in anticipation of falling schedules again are tight as the pipe-lines are being refilled to meet augmented requirements. Men, women, and facilities must be shifted from less essential to more essential tasks. What must be done will be done. But unless there is much voluntary accommodation, it will be necessary for us to suffer a formidable amount of governmental direction which none of us likes, many of us deeply resent, and all of us, when personally affected, volubly protest. The more we police ourselves, the less we shall be policed.

☆ ☆ ☆

Even after Germany has been defeated, we shall still face a far from light production requirement to continue the war against Japan. As currently defined this phase might require war expenditures at something like $70 billions a year, an over-all reduction of approximately 20 percent from the $89 billions spent in 1944. Reduction in munitions output would be somewhat greater, probably from 25 percent to 30 percent below 1944 levels. But it is important for us to acknowledge that the reduction is going to be substantially less than the 40 percent previously estimated.

Only a few months ago there were those who questioned sharply the possibility that we might need 60 percent of current munitions output to win the Japanese war. Now the judgment of the military is that 70 percent will be none too high.

Actually the latter level would represent an increase of little more than 50 percent above what now is being produced for the Pacific area. This, certainly, is a modest estimate when we reflect that we shall inevitably more than triple the Army forces assigned to that theatre.

Such a program probably would give us a current munitions supply from three to four times that produced by Japan, but it is believed that we shall need that much to compensate for the advantages derived by Japan from the fact that she will be fighting a defensive war, from the volume of her accumulated stores, from her prepared positions, her shorter lines of supply and transport, and from her large troop reserves, the bulk of which we have yet to meet in battle. Certainly our present 3 to 1 production edge over Germany does not appear to be excessive.

The more modest V-E Day cuts contemplated by the present plan will mean a less acute reconversion problem when they are made, but will leave a greater one to be met at the end of the war. They will mean probably a net increase of not more than 4 million workers available for civilian work during the transition period. Their orderly absorption should present no embarrassing problem. Indeed, we now are warned by Washington that war production following V-E Day may require the protection of considerably closer control than was contemplated under the 40 percent cuts previously expected.

☆ ☆ ☆

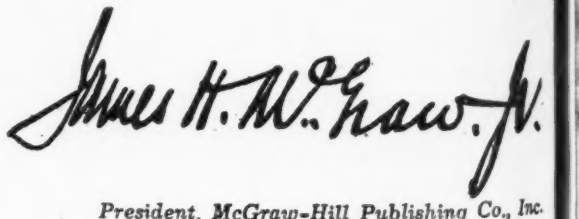
In short, we face for the immediate future a more difficult production job. It is made the more formidable by the fact that we had dulled the keen edge of our will to produce by our premature expectation of a reduction in requirements. Now we are told that the trend of war production for the immediate future is up, that it is unsafe to discount the date of victory in Europe, and that the amount of leeway for reconversion after the defeat of Germany is less than had been anticipated.

Accordingly, we must rededicate ourselves to the task of driving war production up. We must do without some of the things that we have enjoyed on the civilian front rather than demand more of those things; we have still to devote our abilities and energies first and foremost to the demands of war.

Whatever will assure and hasten victory must have first place in any statement of American policy.

Without victory, our aims, and the underlying values upon which they are based, will be extinguished, blotted out by the opposing aims and values proclaimed by our enemies.

The needs of our fighting men must be put first. For, unless we win the war, the National aims and policies of the United States will cease to have meaning in the world.



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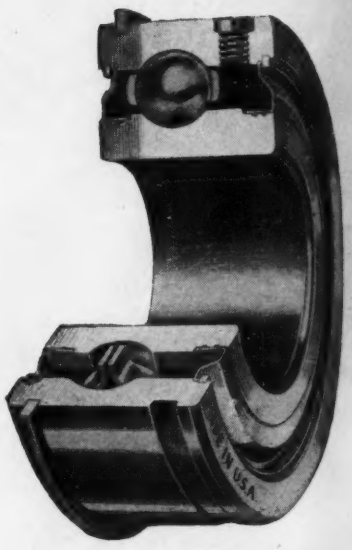

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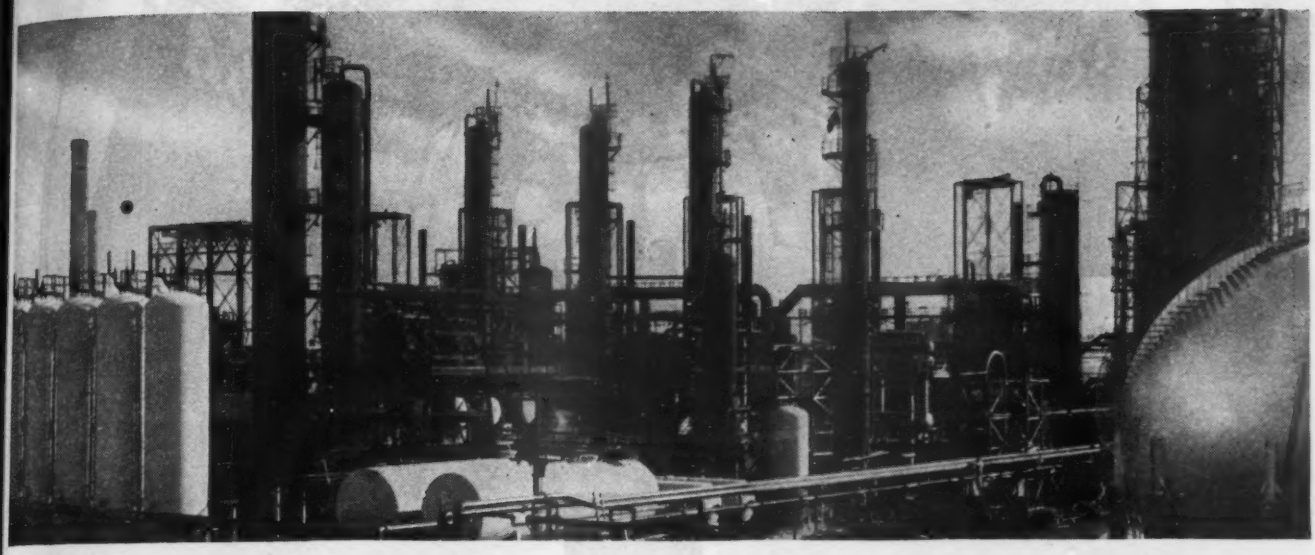
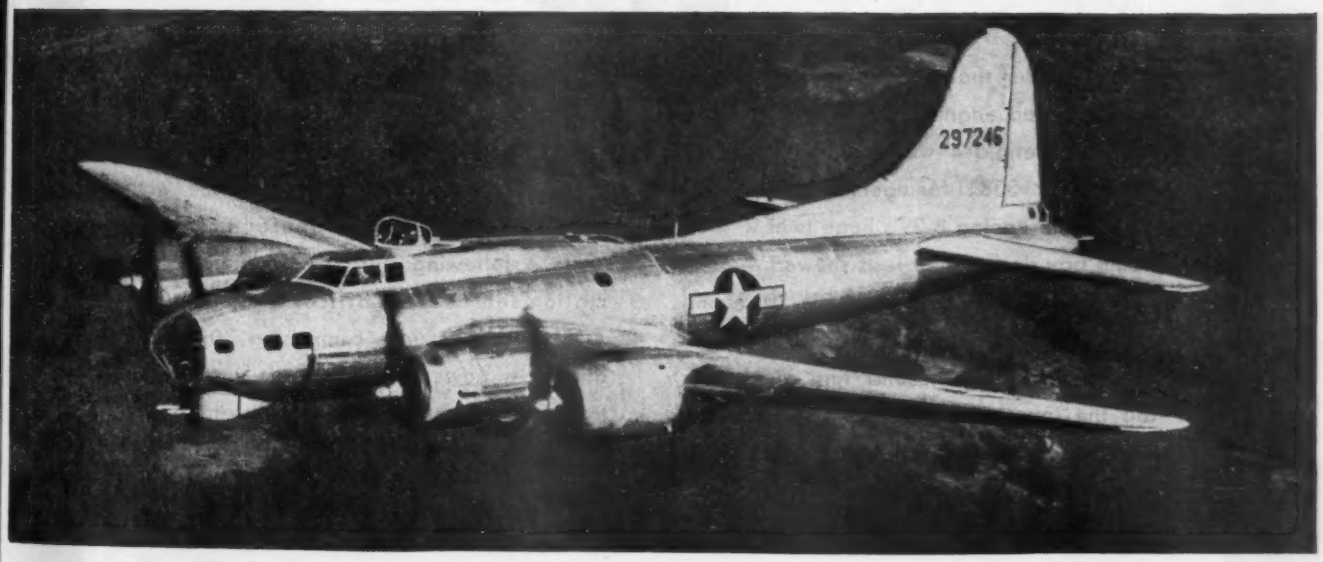


NEW AVIATION GASOLINE UNITS of most modern design at Sinclair refineries, are now producing 100-octane gasoline. Sinclair's output of this vital fuel runs into thousands of barrels a day.



SINCLAIR 100-OCTANE gasoline all goes for war uses today. But it will be available later on to power the new sky giants planned for commercial flying on national and international air routes.

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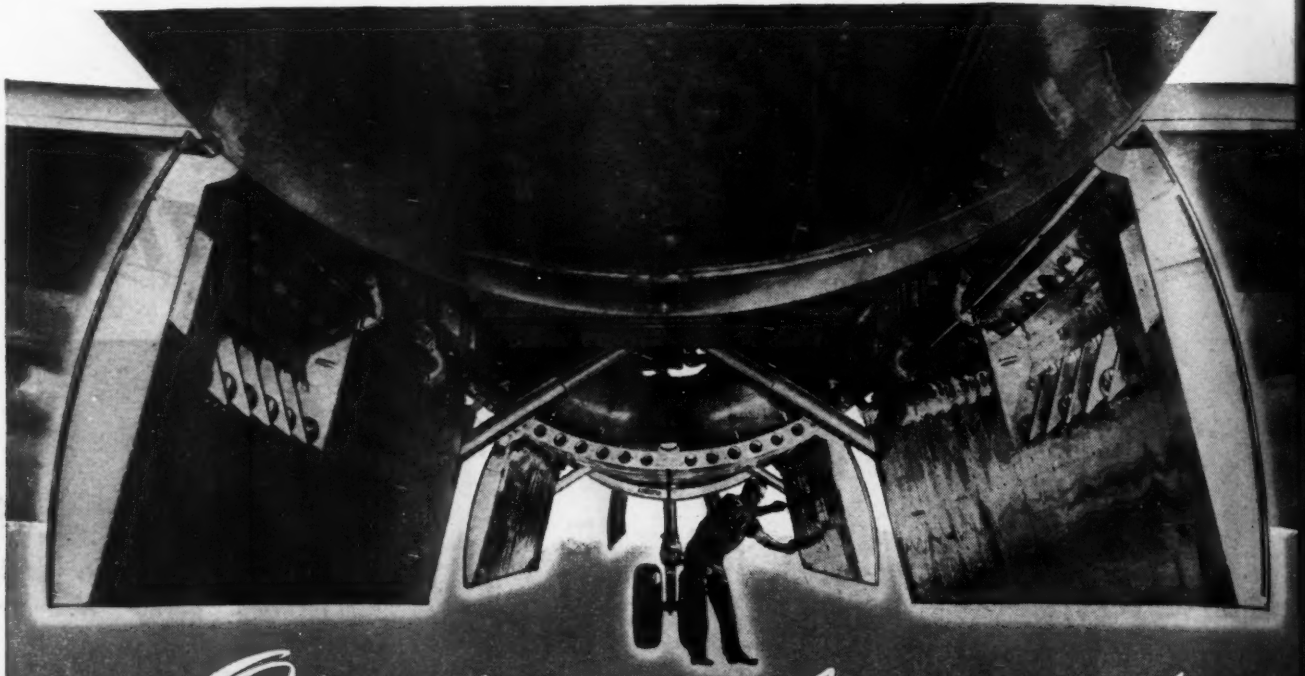

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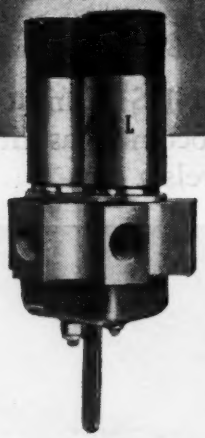

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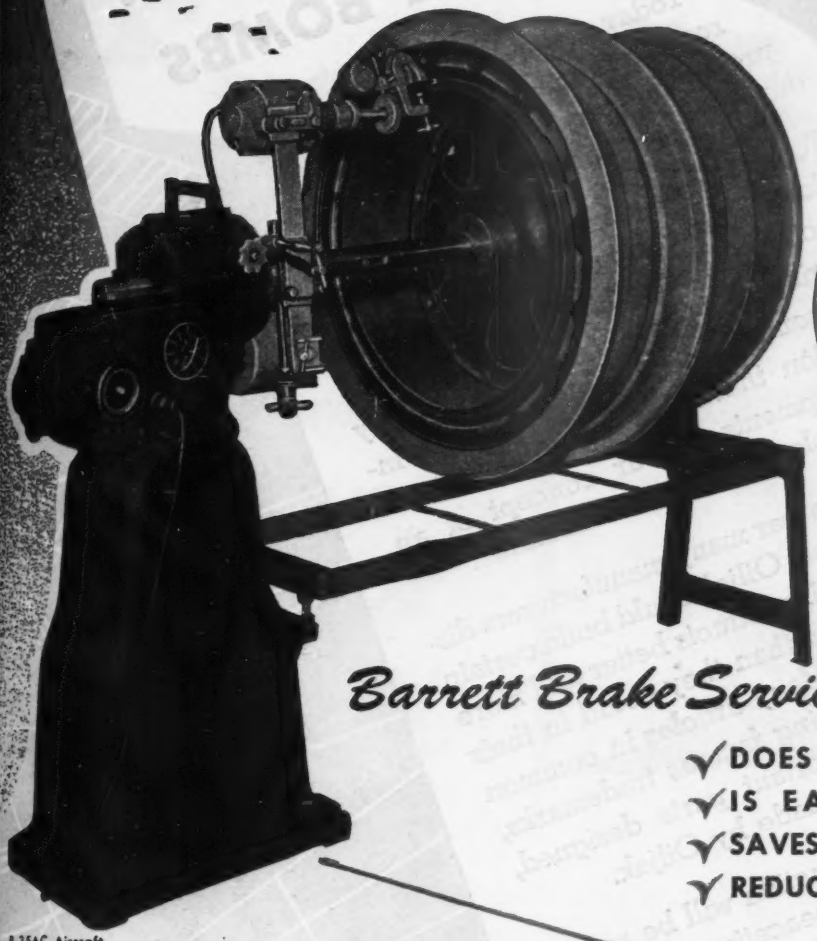

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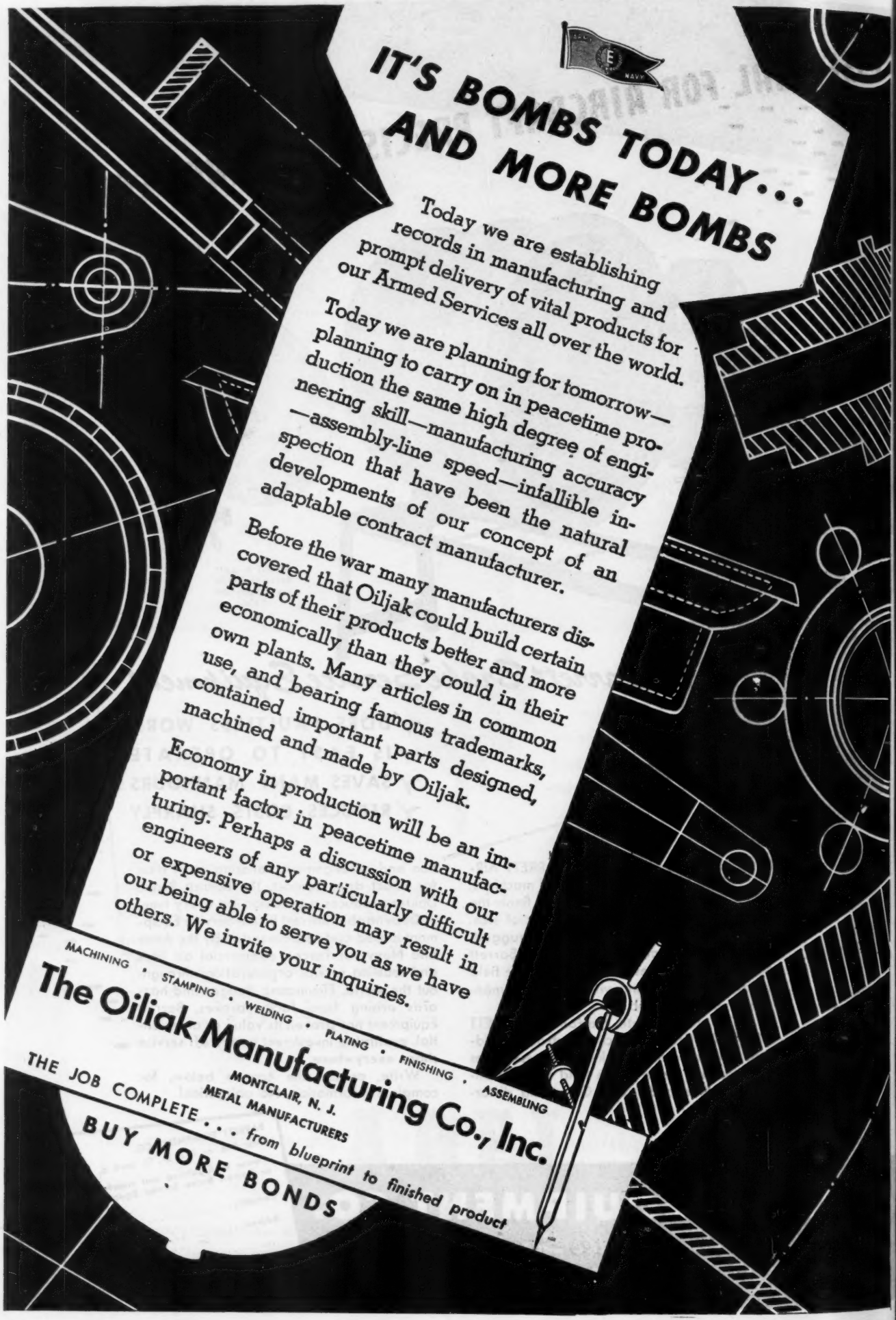
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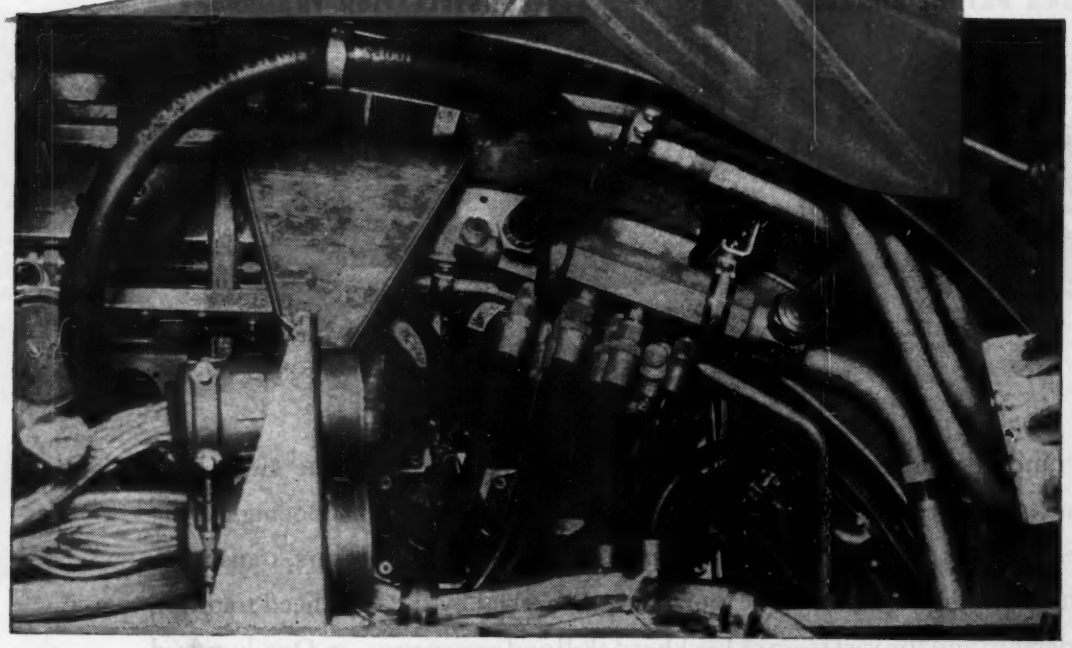
FLEX-O-TUBES
IN THE NOSE OF THE B-24



Flex-O-Tube hose assemblies are to be found in the nose of the Liberator B-24 built by the Consolidated Vultee Aircraft Corporation.

These hose assemblies have proved reliable on aircraft, on automotive equipment, on road-building machinery and in many other fields. Flex-O-Tube engineers will give you any information on flexible hose assemblies you need.

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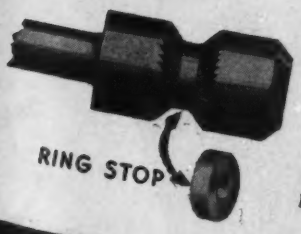

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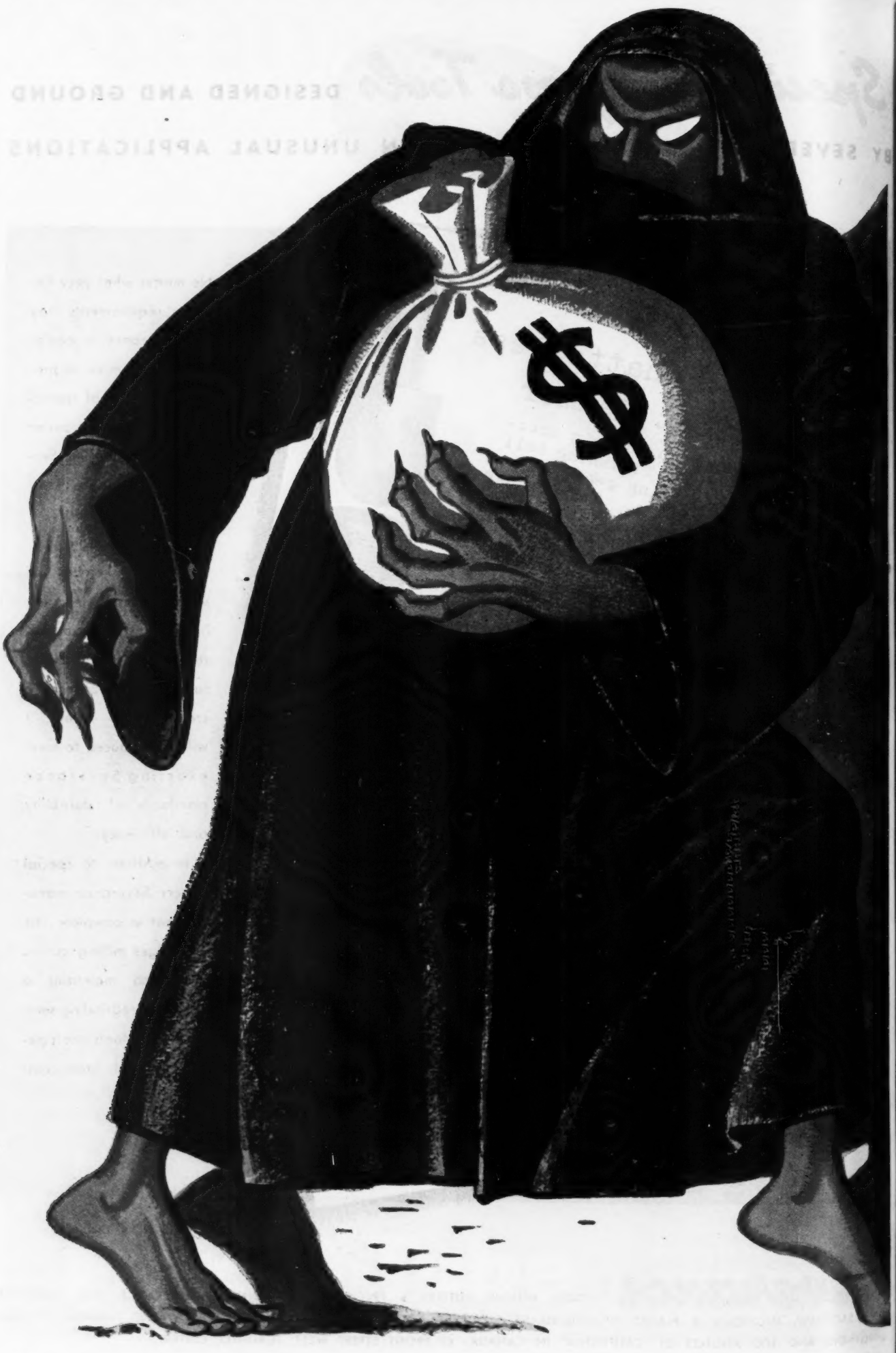

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Stop that thieving demon RUST with new

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Because the cost of rust is the total of a lot of big and little losses. Depreciating equipment . . . ruined materials . . . worthless finished products. *Plus time wasted all along the line!*

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Shell Tellus Oils do not *remove* rust . . . However, where moisture is a factor, special rust-inhibiting qualities built into them afford protection against the formation of rust, without sacrifice of other valuable characteristics.

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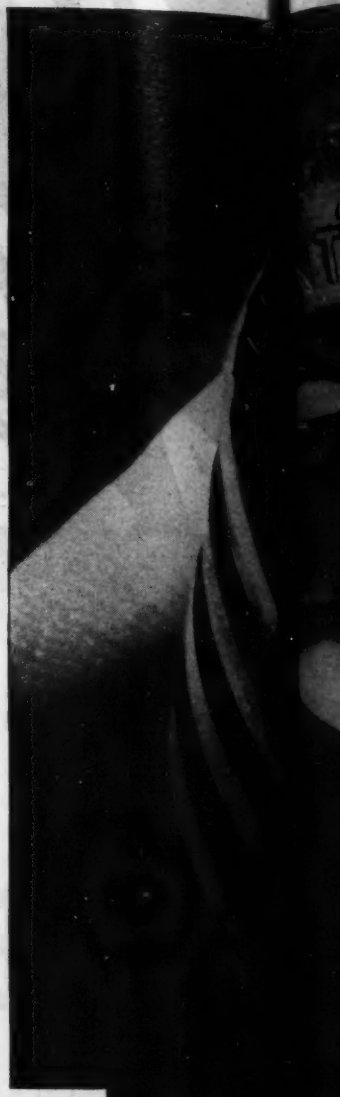
PROVED FOR YEARS on industrial piping applications, B. F. Goodrich Flexlock couplings are now being adapted to many aircraft uses. They are effective as seals or flexible joints, and are ideal for uses where vibration is a problem.

The Flexlock coupling is a molded rubber gasket specially ribbed inside and out. Coupling is placed in the larger diameter pipe and the smaller pipe forced inside the coupling. Compression causes the ribs to grip both pipes securely. The result of the gripping and sealing action of the inner and outer sets of ribs is a tight joint.

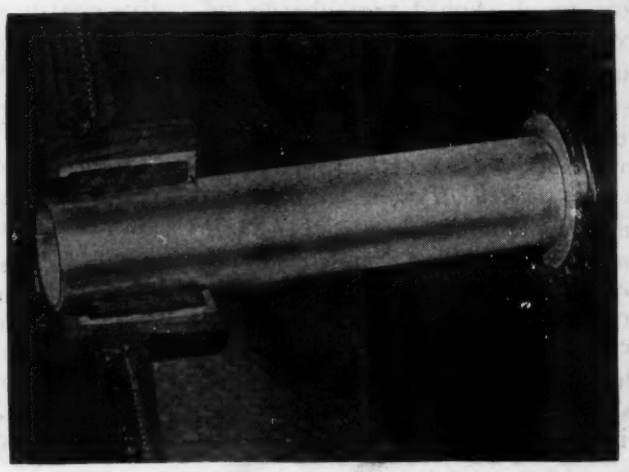
Flexlock couplings have five outstanding advantages: (1) *Quick application*—takes only few seconds; (2) *Low cost*—time saved and low cost of seal itself make Flexlock cheapest method in many cases; (3) *Adaptable*—adapts itself to rough surfaces; (4) *Leak-proof*—constant pressure is exerted on all surfaces touched by seal; (5) *Positive flexible coupling*—vibration won't loosen Flexlock.

B. F. Goodrich Flexlock couplings can be made of natural or synthetic rubber, depending on use. Rubber can be compounded with resistance to aromatics, hot and cold gases, and liquids such as commercial acids, alcohol, water, gasoline and oil.

Flexlock couplings are available now for experimental uses, some of which are described below. Our engineers will be glad to work on applications with you. Write to The B. F. Goodrich Co., Aeronautical Division, Dept. A-2, Akron, O.



• SUGGESTED USE of Flexlock in fuel system to show how it might be applied. Cutaway section shows how ribs grip both pipes securely. Other possible applications—high pressure grommet seals for passing conduits through pressure chamber bulkheads, etc.; flexible joints in bell and spigot tubing carrying gases and liquids.



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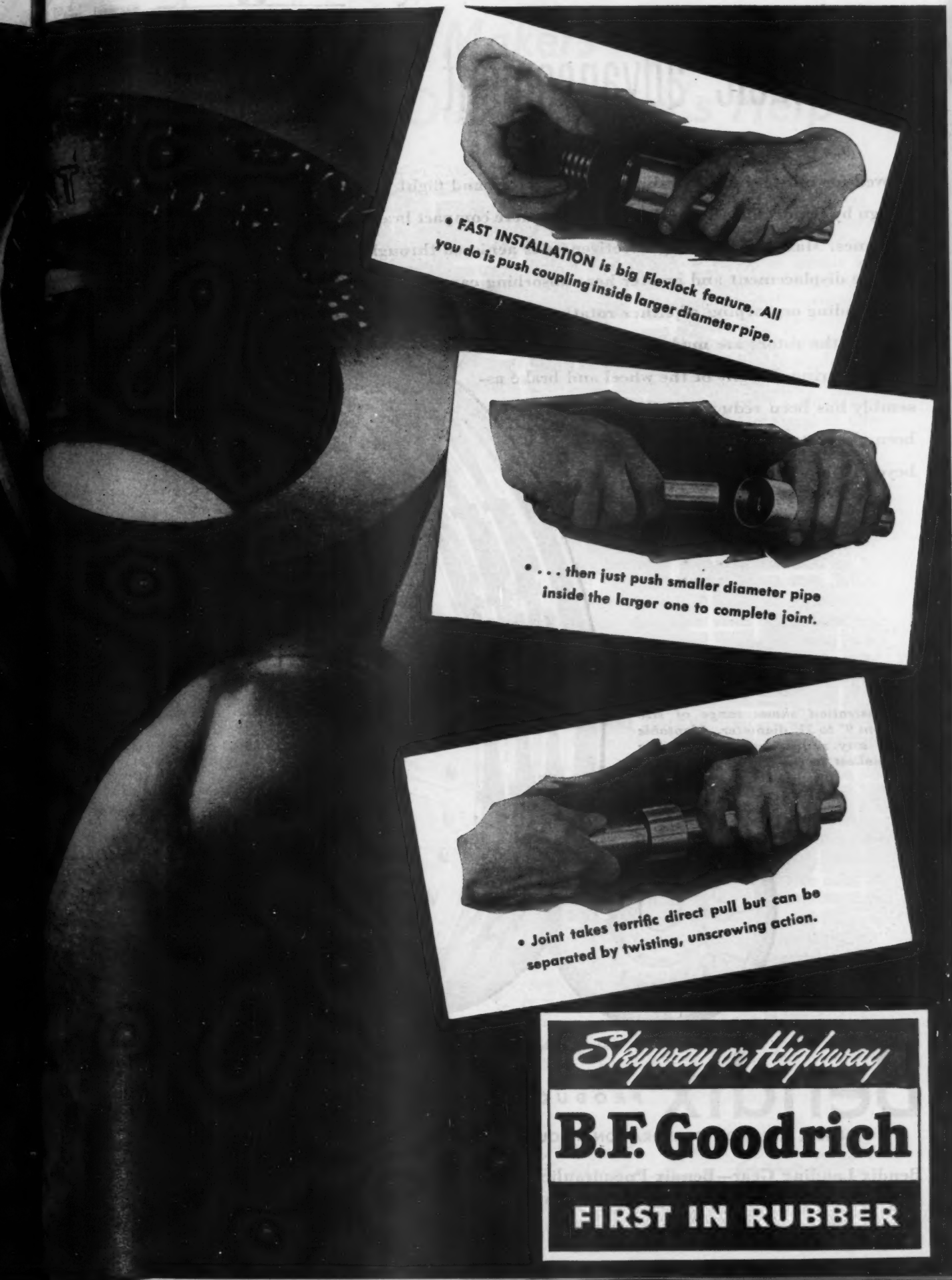
airplane plumbing lines



• FAST INSTALLATION is big Flexlock feature. All you do is push coupling inside larger diameter pipe.

• . . . then just push smaller diameter pipe inside the larger one to complete joint.

• Joint takes terrific direct pull but can be separated by twisting, unscrewing action.

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Proved for military use by exhaustive laboratory and flight tests, this new brake design by Bendix fills the need for a simple, more compact brake for all types of planes. Maximum braking effectiveness is achieved through low hydraulic displacement and greater heat absorbing capacity. There is no fading or warping of either rotating or fixed members because the rotors are made in sections rather than a complete ring. Weight of the wheel and brake assembly has been reduced and the brake has been held to a minimum extension beyond the wheel.

Illustration shows range of size from 9" to 31" diameter. Adaptable to any requirement from the smallest to the largest ships.

Design Features

Fixed discs are faced with friction lining; lining is segmented in such a way as to scavenge lining dust and provide air circulation. Eliminates fading and gives greater braking force with less contact pressure. . . . Rotating members, keyed to the wheels, provide large heat-absorbing capacity. . . . Rotors are made in segments instead of a continuous ring; this allows for heat expansion without warping or cracking.

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America's Policy Makers Need Our Industry's Help

IN THE MONTHS that lie immediately ahead the basic pattern for the postwar aviation industry will be wrought. The whole future of aeronautics in this country depends upon the imminent decisions of the present Congress and of the several government agencies concerned with problems bearing directly on our national air power policies. In a larger sense even the future security of the nation depends upon these developments because the war has shown with great clarity how closely the future of aviation and the future of the nation are intertwined.

Important decisions will be made to determine the principles governing the disposal of war-surplus aircraft and aviation equipment. This is one of the knottiest problems before us. The effectiveness of its solution will affect the future of every branch of the aviation business. Unless the market is relieved of the huge surplus which is bound to accumulate before the war ends, there is grave danger that the manufacturing talent of the industry will be scattered to other fields and perhaps never re-assembled.

The disposition of government-owned manufacturing facilities will come in for further examination and the proponents of nationalized industry will be heard advocating that the industry be placed in the position of competing with its largest customer. One of the most eloquent answers to this fallacious thinking is the prewar French experience in which government ownership so demoralized industry that even the hope of adequate war production faded before France fell.

THE DELICATE DEMARCATION between the functions of government and industry in research and design development is scheduled to be worked out by this Congress and a projection of past practice will furnish a sound formula for the future. The public interest demands a continuous and highly accelerated program of technological development which is the very life-blood of aviation. The government laboratories must not overstep their vital responsibility of providing basic research (they have effectively refrained in the past). The armed services must continue their catalytic action in evaluating progress and encouraging the industry to develop new and better designs in an unending procession. Peacetime procurement policies must be devised to eliminate enough of the gambling element in experimental contracts to enable manufacturers to justify them before their stockholders. And the industry must not shirk its responsibility to utilize basic research to create the finest aircraft and equipment in the world.

Our national policy with respect to airport development will probably be formulated this year. The division of financial responsibility between the federal, state, and community governments should be determined, and a long-term plan to build airports as we have built highways should be set up as quickly as possible. Much of the future growth of personal flying depends upon government and community activity in this field.

Many other problems vital to aviation's future will be ironed out this year. The move to relax regulations governing personal plane operation and the development of a postwar network of feeder airlines are prominent among them. The center of much of this policy formation will be the nation's capital, but other matters vital to aviation will be considered by various state legislatures.

THE MEN who are charged with the grave responsibilities of policy-making in government are not supermen. They are normal human beings, even as you and I. And they are thirsty for competent information to help them do their difficult jobs more effectively. In the past they have often been misled by crackpots and publicity seekers whose testimony was based more on self interest than on the truth. And the public servants were forced to depend upon instinct to distinguish between the unsound and the sound. It was not until recently that the industry leaders who really know the score took time out to go to Washington to present the facts.

The handful of aviation manufacturers who have taken valuable time out to present the truth about the industry to the various agencies of government deserve high commendation for their foresight and their contribution to the future of the industry and the nation. They have been welcomed by members of both political parties. Their strength and their effectiveness have been born of their willingness to present facts impartially without trying to hide any part of the truth.

This work must go forward in the critical months ahead because there will always be new problems in an industry whose very basis is rapid change. It is the responsibility of every member of the industry to support this activity and to contribute to it when called upon. By so doing it will be possible for aviation to establish an example of industry-government relationship which it will behoove other industries to follow.

Leslie E. Neville

EDITOR

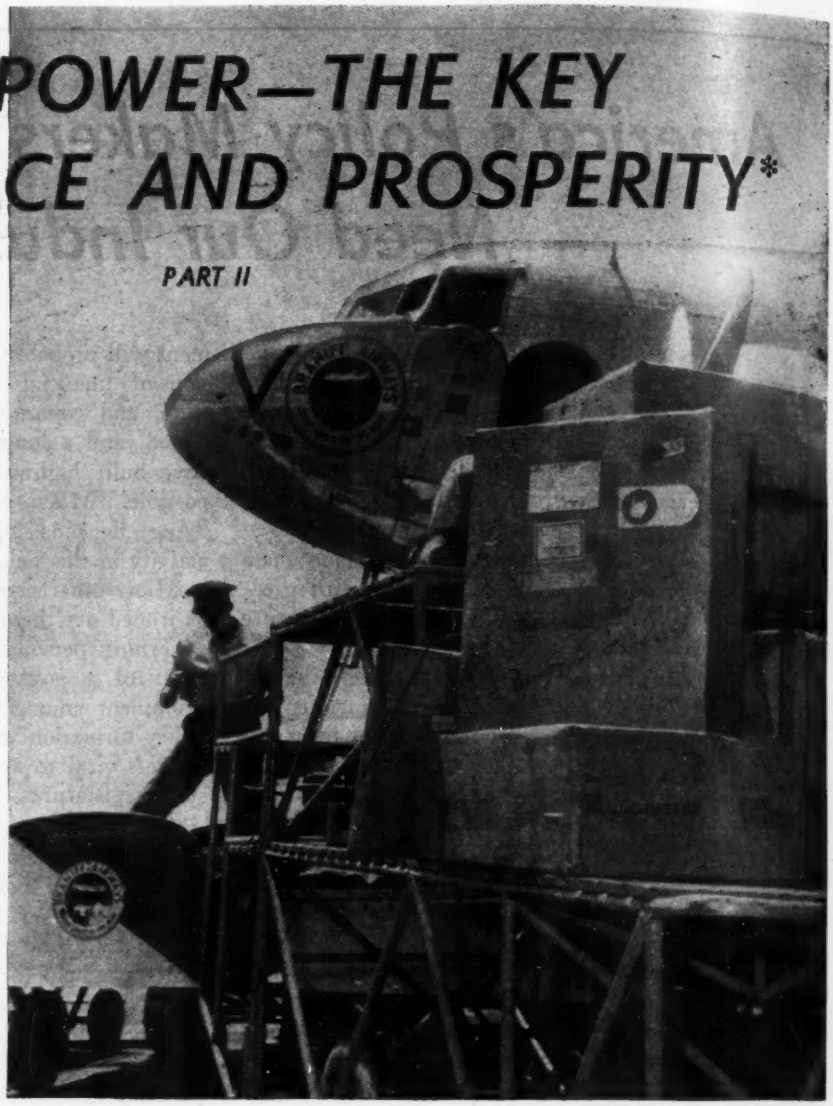
AIR POWER—THE KEY TO PEACE AND PROSPERITY*

PART II

By **EUGENE E. WILSON,**

Vice Chairman, United Aircraft Corp., and President, Aeronautical Chamber of Commerce

One of aviation's foremost spokesmen here gives the ingredients for a national air policy which might well foster the world's fourth great — and possibly permanent — era of peace, the Pax Aeronautica.



"One of the great forces for peace is freedom of access to the goods of the world . . . Air Transport can become the catalyst of a new dynamic era of expanding commerce." (Braniff Airways photo)

AIR FORCES have been developed in this world of ours only on the basis of national policy; peace-loving nations like the United States developed their aviation industries along the lines of commerce—Germany and Japan developed theirs for aggression.

It was only because the United States had strong Air Commerce—what we commonly call air transportation—and an unparalleled Aircraft Production potential—that it was able to build up an Air Force equal to those of the aggressor nations.

While World War I influenced the development of the airplane more than the airplane influenced World War I, the exact opposite has been true in the current conflict. Thus it will be well to appraise the coming peace as it is surely to be affected by Air Power, that is, the sum total of Air Force, Air Commerce, and Aircraft Production.

All will be greatly affected by national policies—foreign and domestic—and such policies must have regard for the truly fundamental character of Air Power. For here is a new medium of communication and commerce, a medium of unique character and far-reaching influence.

We have seen the French Air Force disintegrate under a lack of progressive policy; we have seen the British, whose maritime policy had helped make the inhabitants of a small group of islands the founders of a world empire, function less surely in the air. We have seen the Germans, disarmed by treaty, re-arm and combine Air and Ground Forces in a bold bid for world power that came too close to success. We have seen Italy and Russia and Japan make their bids for Air Power. Of the three, it is possible Japan had the broadest concept.

It should be recalled that during the Washington Limitation of Armaments Conference and the London Conference, when Japan was apparently accepting the 5-5-3 ratio of surface ships. Brig. Gen. William Mitchell was forecasting the passing of the battleship—and Adm. William E. Sims agreed with him. The Japanese statesmen must have been impressed with this, and, when the U. S. carrier force maneuvered in the Pacific, must have understood the significance of Air Force that we in the United States hardly appreciated.

In any event, Japan not only expanded its naval air forces, but apparently assigned to seaborne aircraft a vital role. History may record that the navy was actually relegated to third place in their thinking, and the air forces, however administered, charged with responsibility for controlling the sea lanes.

However this may be, we find that German and Japanese ambitions were finally thwarted only with the decisive help of American Air Forces. Behind the fighting forces of the United Nations was the overwhelming flood of superior aircraft designed and produced by the American aircraft industry, the largest industrial establishment in world history.

America's air policy, as outlined by Dwight Morrow, was quite simple. It recognized a strong Air Force as a vital necessity to our national security. It saw the backbone of the Air Force as a strong, competitive, private industry, able to maintain technical leader-

* From the manuscript of the author's forthcoming book *Air Power and Peace.* (McGraw-Hill Book Co., N.Y.C.)

ship and to expand in an emergency to carry the first brunt of war while the remainder of industry was being converted. It recognized the place of Air Commerce in peace and war, and of personal flying and the training of youth in aviation. It indicated the necessity for planned programs designed to give continuity to development and production, and the healthy financial condition so essential to progress.

Out of it came a fundamental concept of the mutual interdependence of the armed forces and Aircraft Production. The Army and Navy had to direct a program that would bring to bear the full creative force of performance competition, and still avoid destructive financial competition. This same principle controlled the orderly economic development of Air Transport, domestic and foreign. Reasonable regulation provided all the incentive of free competition without the destructive disadvantages of unlimited competition.

The line of demarcation between government and private industry was carefully drawn, yet both were well integrated. Business relationships between the commercial airlines, personal flyers, and personal plane manufacturers were the normal relationships of private individuals. The government refrained from competition with private industry, both in design and production. The armed forces evaluated the results of competition in the laboratory and in the field. They laid down their own requirements and usually required the "impossible." But invariably it was forthcoming.

Here is a pattern for relationship of government to the individual or organization that is wholly within the spirit of the American concept of individual freedom under law. It is a pattern that could well be followed in other industry-government relations in the future. Freedom is not alone a pleasant material condition but a vital, dynamic, constructive spiritual force that has produced the greatest power in world history.

The pattern of domestic air policy is well established. That for the foreign field remains to be delineated as the world works over the foundation established by the International Civil Aviation Conference held late last year in Chicago. Here we move out of the realm of Air Force for war, and into that of Air Power for peace.

The function of the Air Force in peace has already been outlined by the Dumbarton Oaks Conference. An Air Force to comprise contingents from the Powers will be the instrument of security—a Security Air Force. And Air Force is suited to this purpose to a degree not approached by Ground or Seaborne Force. Its capacity for action directly against a people, rather than against their armed forces, is a decisive quality.

If no agreement can be had as to collective action, then the responsibility will rest on the individual country. The United States has two instruments available for this purpose, and can use one or both as circumstances dictate. The Army's long-term striking force, using self-sufficient Boeing Superfortresses and Convair Dominators is one; the Navy's Seaborne Air Force is another.

But we must not lose sight of the fact that these forces must be kept at a high state of readiness and advanced technical development. The buzz-bomb and rocket bomb forecast rapid changes; still other developments are indicated. These highlight the place of aircraft design and production in the Security Air Force.

The future of this country in peace and in war is to a great extent in the hands of American scientists in industry, in universities, in schools, and in government. The leadership, in connection with the development of new weapons, must rest in the armed services, but the actual research, engineering, and development must rest in private hands and be stimulated by the natural forces best calculated to accelerate it.

The outstanding lesson of this war is the miraculous power of individual initiative and enterprise under freedom. This has shown itself not only in industry but in the armed services as well. Both Aircraft Production and Air Transport flourished in the United States under the stimulus of private competition, reasonably regulated in the broad public interest. Under this policy, skilled designers and creative engineers conceived new technologies to obsolete the old and provide new employment and wealth for the many.

Meanwhile, the need for an Air Force is importantly influenced by other things. Among the causes of war is disruption of commerce and trade. One of the great forces for peace is freedom of access to the goods of the world. Another is domestic prosperity, and the two go hand in hand. The earlier commerce is restored, the less the need of an overwhelming Security Air Force. Here is the opportunity for Air Transport.

Air Transport, under the American system, has proved self sustaining even in direct competition with highly developed surface transport. In the reconstruction period following our Civil War, the railways furnished the mechanism for expanded trade and industry. Similarly, following World War I, the automobile was the new vehicle

LEFT: "The outstanding lesson of this war is the miraculous power of individual initiative and enterprise under freedom," which put behind the fighting forces of the United Nations "the overwhelming flood of superior aircraft designed and produced by the American aircraft industry." Seen here are both AAF and RAF Liberators interspersed along production line in Convair plant at Fort Worth. RIGHT: New class of cadets arriving at AAF training center to win their wings. "Thousands of young men in their early twenties have learned to fly and to command large and complicated aircraft." They and their crewman constitute "a new force for international expansion," continues Mr. Wilson, "and Air Commerce should provide new opportunity for them."

about which reconstruction focused. The progress of mankind has paralleled the progress of transport. Now, the airplane, forged in the crucible of war, may become the instrument for forging a durable peace.

If Air Transport served only as a means of bringing leaders of government and industry into quick accord on the measures essential to the restoration of trade, it would justify itself. But, of course, it has a far greater role than that. Coordinated with other forms of transport, it can become the catalyst of a new dynamic era of expanding commerce. And the economics of Air Power are such that this requires no subsidy under reasonable regulation.

For instance, as the world progresses, new sources of oil will have to be developed. Much of the world outside the United States has been only lightly prospected. If Americans continue to participate in the work of finding oil, they will need international air transport to every corner of the earth—air transport which translates the great distances of the globe into hours instead of weeks and months.

This is but one of many examples, for nature has distributed materials and peoples all over the globe. No nation or people is self-sufficient. Each needs to trade with others on terms advantageous to all. Tourist travel is one form of trade. The wide variations in living standards among peoples is a challenge to statesmanship. Unless it is met, frequent wars seem inevitable. Enterprising traders of the past found ways to trade under even greater difficulites than those now encountered. They are likely to repeat.

A great new force has been released upon the world. Thousands of young men in their early twenties have learned to fly and to command large and complicated aircraft. They and their crewmen have had a taste of individual initiative, of leadership, and of teamwork they might never have experienced in peace. Some of them will want to range far afield in pioneering new countries, new air routes, new enterprises. Some will not be content with the old routine. They form a new force for international expansion, and Air Commerce should provide new opportunity for them.

From the viewpoint of Aircraft Production we see that if, as the demands of the Air Force diminish, the requirements of Air Transport increase, the reconversion of the manufacturing establishment is facilitated. A growing demand for new and improved transport becomes the basis of transition from war to peace.

Disposal of war surplus transport planes may well create a demand for newer types if it is handled on a sound economic basis designed to expand domestic and international transport. On the other hand, dumping of war surpluses, or permitting them to overhang the market, could quench the spark of recovery.

In fact, in order that the aircraft manufacturing establishment may even survive the drastic cutback from war to peace, several steps are necessary: First, contracts must be terminated in the same spirit in which they were initiated; second, production must continue at greatly reduced levels on a long-term continuing program of output of advanced transports and new military models; and third, war surpluses must be administered courageously in the public interest so as to fan the spark of technological progress and not extinguish it. Aircraft Production as the backbone of Air Power is a public asset to be cherished and conserved.

This brings up a whole new relationship between the requirements of national defense and their impact upon the economy. It is commonly accepted as a fact that expenditures for national defense are a burden tending to depress living standards. However, under the processes by which U. S. aviation has developed, there were compensating factors. The armed forces, seeking technical progress, fostered technical development through private industry. Those improvements susceptible of employment in Air Transport paid a return and tended to reduce costs.

The expansion of economical Air Transport on a profitable basis contributed to lowered travel costs and reduced express rates, thus promoting domestic and foreign commerce. The supporting manufacturing and other services shared in the enterprise. New employment and new investment opportunities sprang out of the application of new technology to trade and commerce. Air Power, acting through Air Force to keep the peace, can function through Air Transport and Aircraft Production in the same service. And while it may prove impractical to balance the wealth created by this new industry against the costs of new and improved equipment for the Air Forces, it is obvious that substantial sums will be recovered.

In fact the recovery could, in time, exceed the original cost just as it did in the Western railroad construction. Beyond this the savings resulting from maintaining an adequate air force as insurance against war are incalculable.

Here indeed is a revolutionary development. Air Power, as we have seen it function in war, has been devastating. Air Power dedicated to peace can be correspondingly beneficent.

There have been three great eras of peace in modern history: The Greek, the Roman, the Victorian. In each, the dominant Sea or Land Power in the hands of free people drove piracy from the high seas and provided the peace conducive to overseas trade. All the other requirements having been met, prosperity prevailed.

Now, we find in our hands a new and even more effective Power, that of the Air. The United States has the dominant Air Power, an unexcelled Air Force, the largest productive capacity in the history of the world, and the most extensive domestic and foreign Air Commerce.

United States air policy is important to the security of her people—if not vital to the peace of the world. Most of the world has agreed with our policy, as was shown by the Chicago conference. Out of it may easily come a fourth and possibly permanent era of peace, the Pax Aeronautica.

Such a peace requires no new theory, but derives from our experience in two World Wars in a single generation. A basis for maintaining that Air Policy—and with it the peace—can be found in the five major points which we present in the accompanying box.

(*Turn to page* 412)

AIR POLICY POINTS FOR PEACE

1. Maintain the Army and Navy Air Forces at the strength and technical proficiency necessary to preclude a successful assault on ourselves or our possessions.

2. Facilitate the growth of an adequate private aircraft manufacturing industry through a planned Air Force replacement and development program, working through engineering competition calculated to promote technical leadership and provide the capacity for emergency expansion.

3. Foster economically sound private domestic and foreign air commerce, utilizing the technical progress of the armed services to reduce operating costs, improve service, and thus recover the costs of Air Force technical progress.

4. Develop a system of airports, airways, aids to avigation, and facilities for the use of the Air Forces, Air Commerce, and personal flying designed to improve the utility of the airplane.

5. Encourage young men and women to study aeronautics, learn to fly, and acquire aviation's spirit and traditions.

Hard-earned experience has now taught us that nothing is so vital to American might and security as our air power. But this formidable force couldn't have been attained or maintained had it not been for the wartime-unfettered functions of research and development. Hence —

WE MUST RETAIN TECHNOLOGICAL SUPREMACY

By MAJ. GEN. KENNETH B. WOLFE,
Chief, Engineering and Procurement, ATSC

AT THE OUTBREAK of war—Dec. 7, 1941—this great industrial nation had an air force which was pitifully inadequate, numerically, to cope with enemies in the West and East who had built up the greatest fleets of combat aircraft the world had known.

But although we were short in planes and men, we were long in initiative and technical knowledge—thanks to a small group of farsighted and airminded men in the army and navy and in private industry. They were the men who, with inadequate appropriations and inadequate equipment worked long hours to keep American aviation technologically abreast with, or slightly ahead of, other nations, during the years of tenuous peace between World Wars I and II.

These men were often faced with the problem of deciding which important new project should be furthered because there were not sufficient funds to develop all the things that promised progress.

A case in point is interesting. It concerns the flying bomb—the weapon which has been used by the Nazis with destructive force against the civilian population of England and to some extent against American troops stationed there.

The first robot bomb—an unwieldly looking flying machine—was developed in 1918 by the U. S. Navy and the Sperry Corp. It performed successfully, carrying 1,000 lb. of TNT for 400 mi. But it was one of the inventions that our engineers had to ignore in favor of more important items—for instance, our highly accurate bombsights, which have made possible the precision bombing of enemy military targets.

That our engineers were wise, in their selection of new developments upon which to concentrate their energies and available funds, has been proved in aerial combat over many continents. American aircraft of this war—virtually all developed before Pearl Harbor—have time and again proved superior in design and performance. But the fact that we should have had to ignore other inventions which might have afforded us the power necessary for earlier victory is a lesson that America should not forget.

Despite inadequate funds, our engineers—both in the services and in private industry—were able to keep us ahead technologically so that, when war did come, the problem was not one of development but of quantity production.

Through their farsightedness they were also able to give us the edge in a phase of aviation which may well be one of the deciding factors of the war—flexibility of design and engineering of our aircraft, permitting us to make constant improvements even while we were in mass production.

An example which shows the importance of peace time development, as well as abstinence from standardization, is the Boeing Flying Fortress.

"When we consider speeds of 600-800 mph., we must think of jet propulsion." Shown here is Bell's jet-propelled P-59 Airacomet, with nacelles housing thermal-jet engines visible under wing roots. Burning ordinary kerosene, plane is in over-400-mph. class. (All ATSC photos)

This shot of rocket-assisted takeoff of North American B-25 Mitchell, during Wright Field test, is substantiating evidence that "it is entirely possible that within a short time, our bombers—and after the war, our airliners—will be able to take off in half the space now required."

The B-17 made its first experimental appearance in 1935—six years before the war embroiled America. It was then ahead of its time, but in the ensuing nine years, hundreds of improvements have been made on the big ship despite the fact that it was in mass production.

Early Fortresses had a maximum speed of 254 mph. at 14,000 ft. Armament consisted of five .50-cal. machine guns, and maximum weight was 34,000 lb. Today, the B-17 does considerably better than 300 mph., and it is protected by 12 to 16 machine guns, most of them mounted in power-driven turrets and fitted with automatic computing sights. Maximum weight is almost 65,000 lb.

This plane is only one of the aerial weapons developed in peacetime years and used by this country in the present war. Work on the Boeing B-29 Superfortress was started in 1939. And the Republic P-47 Thunderbolt, North American P-51 Mustang, and Lockheed P-38 Lightning were all pre-Pearl Harbor designs.

Thus, had it not been for constant research and development, we might still be waiting for a really effective World War II airplane. As it was, it took us almost a year, with virtually unlimited aircraft production appropriations, to get sufficient military aircraft into the field to initiate bombardment missions against enemy-occupied Europe.

The first heavy bombardment mission against Nazi installations in France (Aug. 17, 1942) was flown by 12 Flying Fortresses; contrast that raid with the formations of thousands of bombers and fighter escorts which we are now sending daily against Hitler's inner fortress.

Since the outbreak of war, we have had adequate funds for research and development, and, making effective use of the facilities bought with these funds, our engineers have gone ahead with many improvements which are just beginning to be felt in aerial combat. And we may look for more surprises for the enemy.

Progress Spurred

Some wartime developments of the AAF Materiel Command, now integrated in the Air Technical Service Command, have been concerned with—

. . . Improvements in turbosuperchargers, permitting our aircraft to attain combat altitudes which give them superiority over the enemy. The importance of this development to commercial aviation is great, since operation of passenger and freight carriers at sub-stratosphere levels for all-weather flying safety and comfort has long been a goal.

. . . Pressurized cabins, which permit B-29 crews to fly and fight with much greater efficiency than is possible with cumbersome protective equipment and oxygen masks. The postwar commercial passenger will desire the ease of pressurized cabins while traveling in the sub-stratosphere.

. . . Jet propulsion, a development just beginning to be a factor in military aviation. Its potentialities, so far as commercial uses are concerned, are not yet sufficiently clear to make definite predictions, but we do know that further increases in aerial speed lie in that direction. The propeller-powered plane has about reached the limit of its speed, because propeller-surface air tends to disintegrate as the movement of the blades approaches the speed of sound.

There is no such limitation on jet-propelled planes, and when we consider speeds of 600-800 mph., we must think of jet propulsion. This form of motive power will probably be an important factor in filling post-war calls for high-speed short flights.

Rocket-assisted takeoff and the reversible-pitch propeller would seem to have a more immediate postwar commercial importance. The RP propeller is now the subject of an intense study which has already led to great strides in this field. It is entirely possible that within a short time, our bombers—and after the war, our airliners—will be able to land and takeoff in half the space now required. Obviously, a limiting factor in increasing the size and carrying-capacity of aircraft is the increased length of runways required. The quicker takeoffs with rocket assistance and "braked" landings with reversible pitch props may remove this limitation.

We are now working on bombers of a size, range, load capacity, and armament far beyond anything we now have. The same applies to transports with regard to range and capacity, it being notable that transport versions of the B-29 Superfortress and B-32 Dominator are already in production.

Coincident with these efforts, we are developing better power plants—always working toward more power with less weight—and better fuels for more efficient performance. Propeller de-icers are also being advanced, and we are seeking cleaner aerodynamic lines and greater lifting power for wing surfaces.

Air power because of speed and mobility, has emerged in this war as a first line of both defense and attack. It can carry the war to within a few miles (vertically) of important enemy installations—an accomplishment which (horizontally) requires months of intense and bitter fighting on the part of ground forces. It is not contended that air power alone can assure final and decisive victory. That appears still to be the job of the infantry. But the importance of air power as a strik-

ing force, while concurrently we are assembling necessary men and supplies for large scale land operations, cannot be overemphasized.

America is determined to remain strong and militarily prepared after this war. But it is inconceivable that we would keep 11,000,000 of our men, needed for productive peacetime effort, in the armed forces. As Gen. Marshall has recently suggested, the best procedure will probably be to maintain a comparatively small standing army and limited navy, backed by a partially-trained citizen reserve.

But we probably will maintain, as a protective first line a sizable air force whose power would give us time to mobilize our ground forces in the event that we should ever again be attacked.

It is not suggested that we maintain an air force as large as that we now have in the midst of this greatest conflict for to do so would be an undesirable drain on our national economy. But we *must* keep research and development activities going at full pace. We must have adequate appropriations for continuance of the work that is going on at Wright Field, and we must provide private industry with sufficient orders for new types of aircraft so that this industry will always be in a position to quickly convert to military and naval aviation production should war again be thrust upon us.

Thus, an efficient and adequate engineering and research organization, backed by an aviation industry which keeps abreast of all new developments, should be the nucleus of our air power, which in turn should be the nucleus of our national defense.

By keeping ahead of other nations in the development of new aerial weapons, we can go a long way toward preventing war, for any aggressor nation would know it was licked before starting.

The importance to commercial aviation of such research and experimentation is obvious from the examples of war-born innovations previously cited, which will undoubtedly be adapted for postwar passenger and freight transport.

At Wright Field, we have what is probably the most extensive aeronautical research and development establishment in the world, with the finest equipment and most outstanding complement of skilled personnel. To fail to take advantage of this setup, to advance peacetime aviation and protect America against future wars, would seem to be the height of folly.

We must remember that the aircraft industry is probably the most rapidly advancing business in the world. Designs which would have been considered futuristic dreams 10 yr. ago are now realities.

Quotes Tell Story

The following quotation may help to illustrate the point:

"Every nation at war uses the best equipment that can be obtained. Improvements must be made constantly or one of the hostile forces will soon be outclassed by its opponent . . . The 175-mph. pursuit plane in use now undoubtedly will be replaced by a 200-mph. plane within a few years. Similarly, a better bombing plane surely will make its appearance before long. It probably will be able to carry a 2,000-lb. bomb load and cruise at 100 mph. for over 8 hr."

Does that strike you as funny? It was written in 1926, only 18 yr. ago, by a man who was making a bold prediction—Henry H. Arnold, major, Air Service, U. S. Army, now C. G. of the AAF.

In the same book in which he made that statement, Gen. Arnold said:

"The next war between first class powers probably will start with a host of aircraft arriving unheralded over strategic points. Anti-aircraft guns will bark their protest from the ground and aircraft will rise to give battle and drive the invaders from the sky. Incendiary . . . and demolition bombs will destroy . . . concentration centers and munition factories; but, following precedent, the largest and best equipped air force will be victorious."

Does this sound a bit like a predescription of Pearl Harbor?

These quotations are cited to show that our military leaders have not been unmindful of probable advancement to be made in aviation, of the destructive uses to which these advancements might be put. But, by and large, the lucid forewarning of these men were only brushed aside. They were regarded as scare-prophets. Meanwhile appropriations for military aviation continued to be slashed.

May we never again let the foresight of such men go unheeded!

Newly designed propellers are supported on concrete torque stands in ATSC Wright Field laboratory and driven at speeds far exceeding those demanded in flight, with rain and other atmospheric conditions simulated for test. Recent development, the reversible-pitch propeller, is now the subject of intense study and promises to be of postwar commercial importance.

THE COMING COMPETITION IN FOREIGN MARKETS

PART II OF A SERIES

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

True enough, some luscious plums are ripening out in the export field. But they aren't going to fall right into the contract basket. To get them will require skillful plucking featuring the adroit use of every proven appurtenance of the art—for the veteran foreign rivalry will be plenty stiff.

AIRCRAFT MANUFACTURERS should plan their export markets now if they want a larger share of world trade than they had before the war. The markets are there—but it won't be just a case of moving in after reconversion.

Agents should be sent out to select the representatives wanted in foreign countries. There are, for example, concerns all over Latin America, which, having hangars and repair setups, are anxious to get franchises to handle American aircraft and equipment. American organizations should take the opportunity to pick the cream of the crop while they can. When cancellations come in, it may be too late.

A manufacturer may argue that he's so busy with war orders that he hasn't yet been able to draft his peacetime production plans. That may be, but accepting the initial premise that he is going to make a plane postwar, he should than take a tip from the automobile people. The latter don't know when they can resume car production or what their prices will be, but even so they *are* building their export media against the time when merchandise can be shipped.

One big reason for the industry's complacency regarding foreign trade is the fact that countries in all corners of the world are looking to America right now for transport aircraft. The resultant sellers' market in transport planes may continue indefinitely. But it wouldn't surprise some astute export men if we all wake up some fine morning to find that the British are way out ahead of us on personal plane exports. And the volume of personal plane sales eventually will far outdistance that of transports.

There is every reason to believe that Great Britain will provide real competition for the American plane maker. You can't write off as a competitor a nation that has 15,000 firms making 5,000 aircraft a month. As Sir Frederick Handley Page has pointed out, an erroneous idea has been spread about that British engineering "is done solely in converted cinemas, disused stables, and adapted Olde Tea Shoppes."

Great Britain has to double her postwar exports in order to survive. She is going to be aided by large loans and credits from the United States. And it is fair to assume that she expects to utilize her vast wartime aircraft industry to increase exports.

Britain especially has her eye on airminded Latin America with its $3,600,000,000 in trade balances. Already the lower East of South America —that is to say Argentina, Paraguay, and Uruguay—is in the British trade orbit. Exporters who have traveled up and down the coasts of South America report that they found British agents everywhere, all patiently explaining why they haven't been able to make shipments during the war and following up by making arrangements for postwar trade. The British government has expedited passports and visas for hundreds of commercial travelers who have already left England to sell British goods as soon as they are available for export.

The British are old hands at foreign trade; it has been a major source of livelihood for them. These British agents have been exempt from the draft, whereas we yanked home commercial representatives of draft age. And in their demobilization plans, Britain plans to give priority to the military men who expect to enter foreign trade.

Steps recently taken in London included the appointment of businessmen resident abroad as marketing officials in principal countries. Small firms unable to send their own men will be represented by group agencies. The Department of Overseas Trade has made a survey in 26 countries outside the European battle area for the "Buy British" drive. The surveys are kept up to date, hence all that will be needed on V-E Day will be cables setting out last minute instructions.

At the same time 140 English exporting industries have been organized for the quickest possible trade drive after the war. British officials figure that trade is no longer a purely individual concern and that industries that used to be competitors will have to work together as a team under government control to plan export production to meet the needs and desires of overseas markets.

The need for new products, higher quality in old products, salesmanship, reliability, prompt delivery, and extensive use of the foreign and consular service, is being drummed into British exporters by their government. Furthermore, there will be distribution controls and allocations to make sure that products are available for export whether or not the domestic demand is satisfied.

This accent on giving the export market priority on most peacetime production is an important point for our aircraft makers to consider. Foreign trade has always held a secondary place in the American scheme of things. Moreover, there will be much pressure after reconversion to take care of the domestic market first, and this kind of "selling begins at home" pressure will hit aircraft just at it will hit trucks, tires, and steel. But if the foreign market has to wait, competitors from other countries may step in to snatch away our golden opportunity.

The Canadians are already working the Latin American trade through the disposal, south of our Border, of surplus planes. Remember that Canada's plane production has increased from 900 in 1940 to around 4,000 in 1944. It is even quite possible she will export American-design airplanes built in the

Dominion under war-obtained licenses, as well as her own makes and models.

The Canadians truly lack a variety of planes, but they may make this up in other respects. An export insurance agency, for instance, has been set up whereby the Dominion government will assume many of the risks the exporter himself has to assume here in the United States. Then, too, the Dominion government is empowered to make loans to foreign governments or traders desiring to buy Canadian goods, thus virtually guaranteeing specific foreign purchases of Canadian products.

Some of our own aircraft men have been scanning the Latin American possibilities. We may name some of them: Paul Moss, export official of Bendix Aviation Corp., got on the job months ago by convassing his markets there at first hand; Irving Taylor, of Douglas, made a two months' Latin American tour; Alfredo de los Rios has also been south of the Rio Grande for Fairchild; and Henry Knight, representing several companies, has likewise been on a three months' trip in that territory.

American exporters must adjust themselves more than they ever did in the past to the special requirements of each foreign market, especially regarding quality of products, selling systems, and payment terms. Revere G. Sanders, assistant vice-president of Fairchild Camera & Instrument Corp., who in a recent trip talked to business and government officials of nearly every Latin American nation, found definite resentment against American manufacturers and export organizations because they were prone to making "cash on the barrel head" demands before their merchandise left the wharves here.

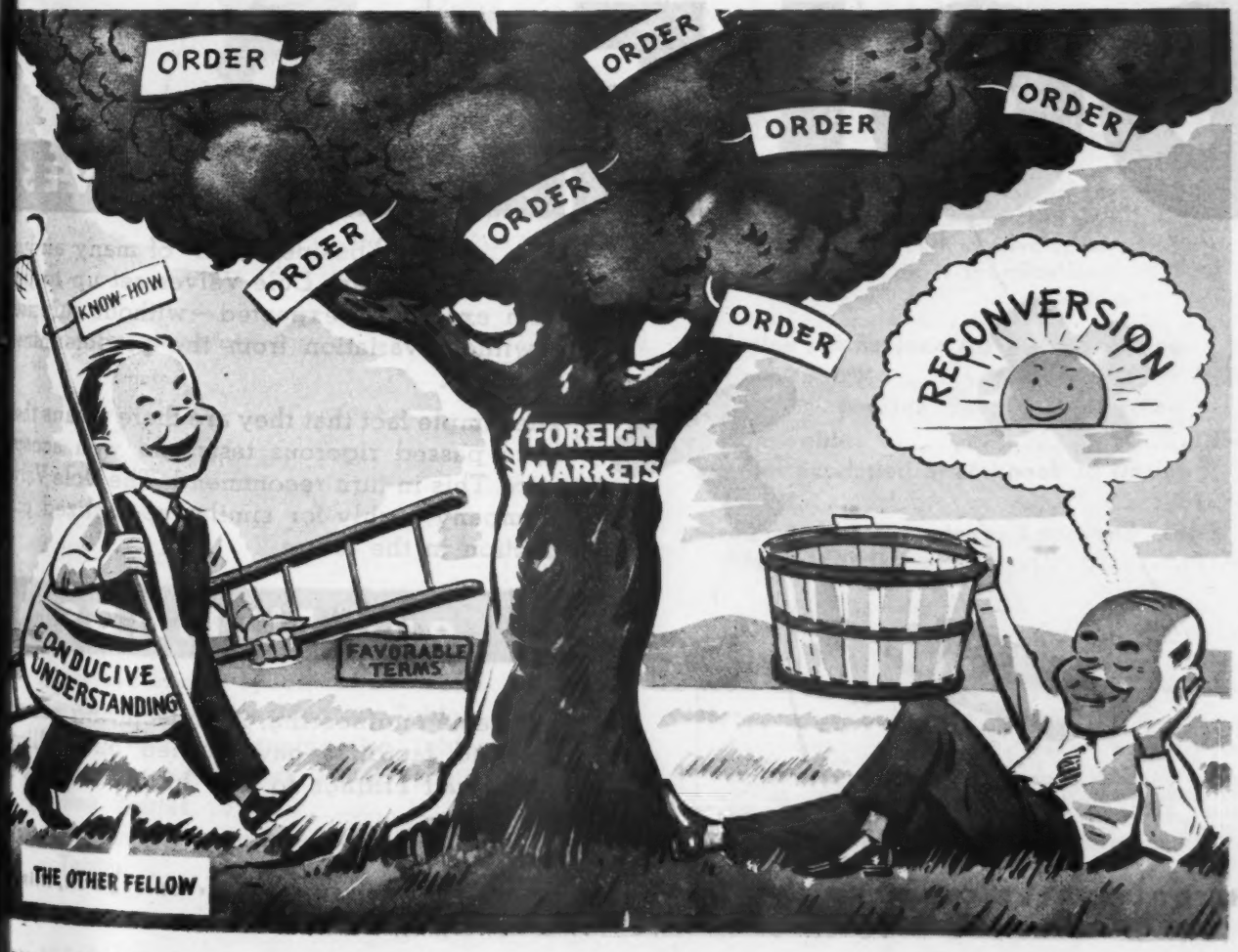
Mr. Sanders believes that if we expect to get and hold foreign trade we must extend credit up to six months, or a year if necessary, even though our customers have the money to pay. He explains that the Latin American businessman operates under the philosophy that it is a reflection on his integrity if someone refuses him credit.

Before the war, points out Mr. Sanders, we would demand irrevocable letters of credit with an order, without making any effort to take into account our customers' methods of doing business. At the same time, an important trade was built up in South and Central America by the Germans, who did accept the basic differences in operational methods and thereby profited.

Companies considering their export operations as of little importance, should either not undertake them or should name experienced export agencies to care for what trade they have. Export handled loosely spells trouble. Deals initially negotiated by junior officers have frequently been turned down later by senior officials, and obviously this is bad business. All basic policy decisions should be reached at home before sending representatives abroad.

War conditions have often made it impossible for senior officers to visit foreign customers. But with the expedited plane services now in prospect, senior officers should plan to do some traveling abroad in order to get first-hand impressions of the countries and the people with whom they want to deal. Certainly the foreign competition will be "on the ball" in this respect.

Next month Mr. Hoadley will conclude this salient foreign-trade series with an article detailing both practical working suggestions and government aids available to help American aircraft companies establish themselves in the highly promising export field.



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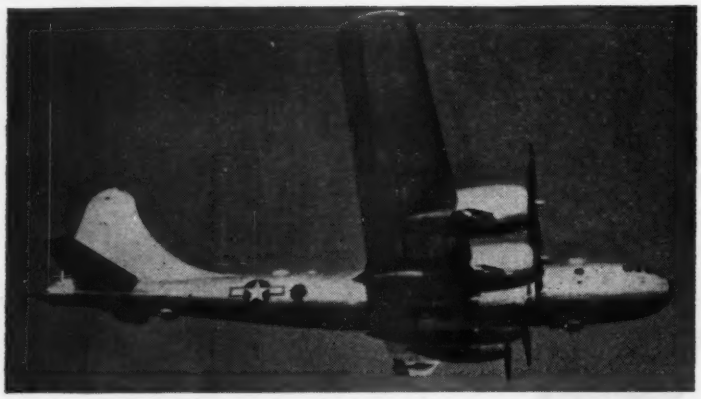
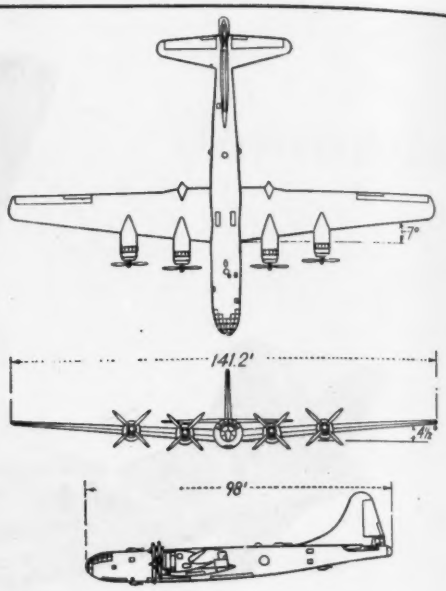
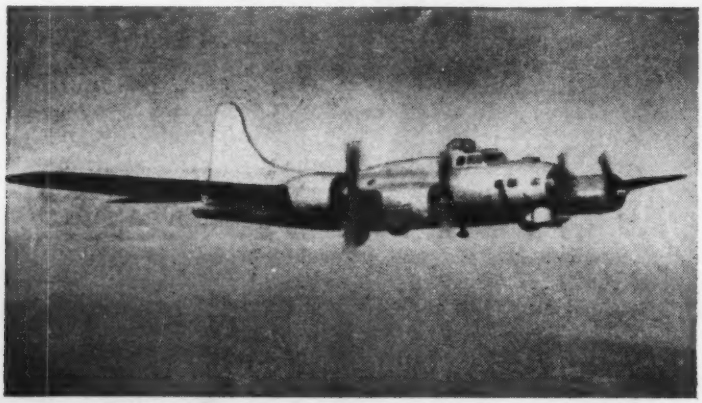
AMERICAN BOMBERS

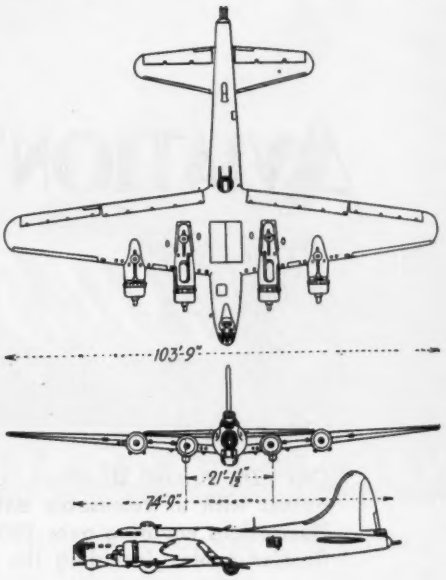




Boeing B-29 Superfortress

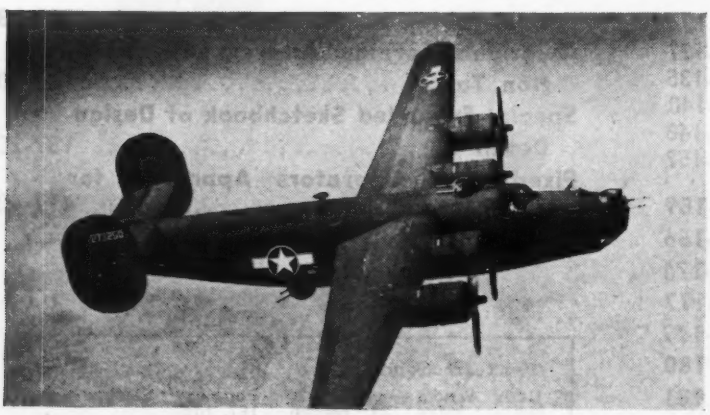
World's outstanding bomber, it carries heavier bomb load greater distances than any other craft. Pressurized cabin permits extended high altitude operations; central fire control system gives maximum defense. Also produced in quantity by Bell and Martin companies, to be built by Douglas and Lockheed.

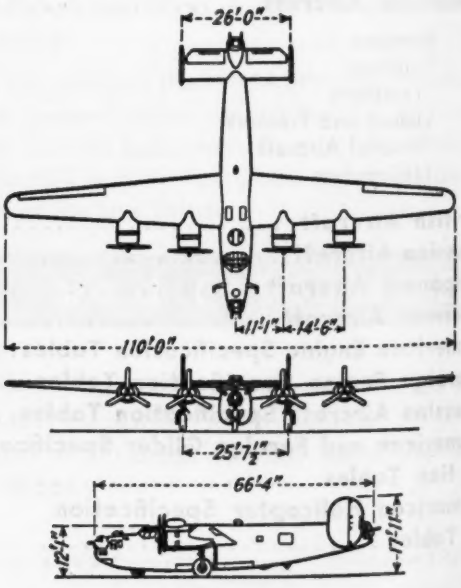




Boeing B-17G Flying Fortress

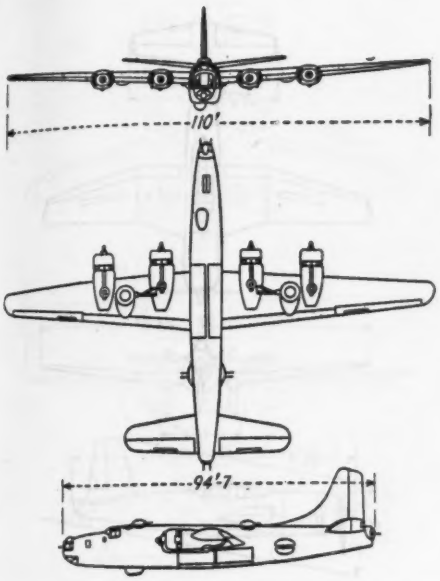
Armament, minimum of 13, 50-cal. machine guns; gross weight, 65,000 lb., bomb load ranges up to ten tons, high speed, over 300 mph., service ceiling, over 35,000 ft., range, up to 3,000 mi. Has also been produced in large numbers by Douglas and Lockheed. Powered by four 1,200-hp. 1820 Wright Cyclone 9's.

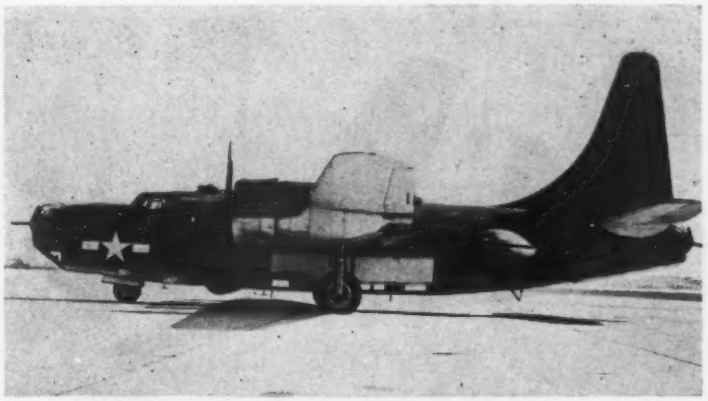




Consolidated-Vultee B-24J Liberator

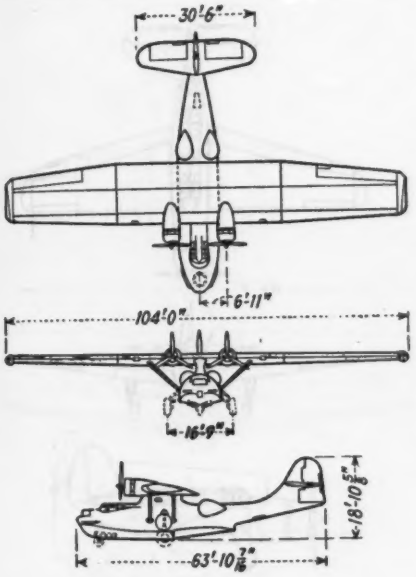
Armament consists of at least ten 50-cal. machine guns; gross weight, over 60,000 lb., high speed, over 300 mph., service ceiling, over 35,000 ft., range, over 3,000 mi. Powered by four turbo-supercharged Pratt & Whitneys. Now being produced under license exclusively by Ford at Willow Run plant.

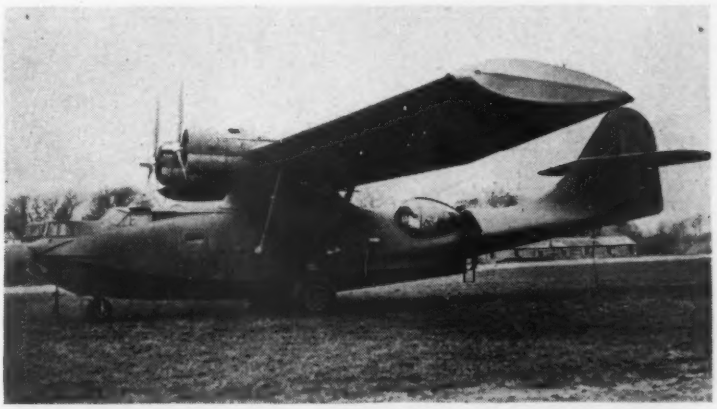




Consolidated Vultee PB4Y-2 Liberator

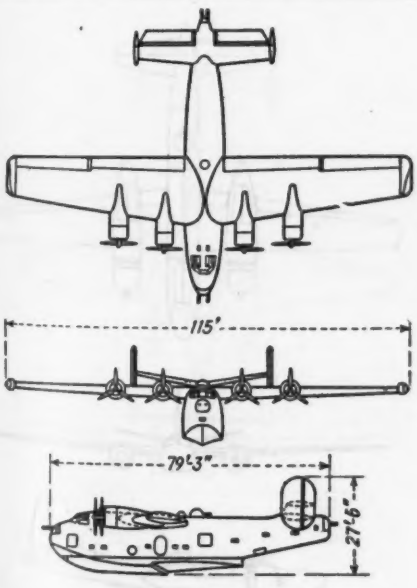
Single-tail Navy modification of basic B-24 design with added armament and gross weight exceeding 63,000 lb. Used on search missions, which means fighting way through any Jap opposition to bomb shipping or shore installations. Powered by four 1,200 hp.-plus Pratt & Whitneys.

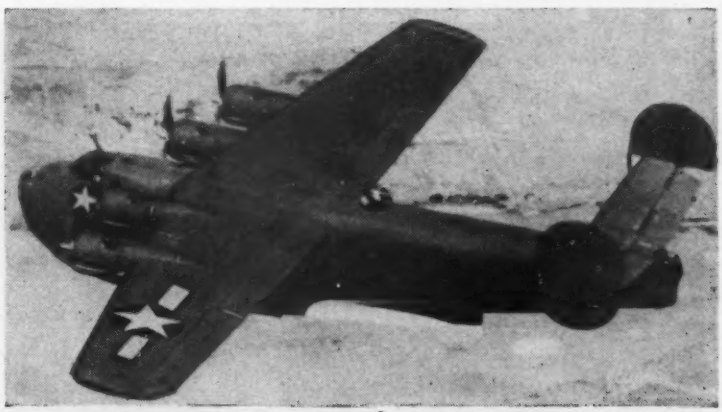




Consolidated Vultee PBY-5A Catalina

Amphibious version of basic design first put in service in 1936. Has given Navy outstanding service, being used as everything from cargo lugger to torpedo bomber. High speed, 198 mph., gross weight, 35,000 lb., range, over 3,000 mi. Powered by two 1,200-hp. P & W's. Has also been widely used by RAF.

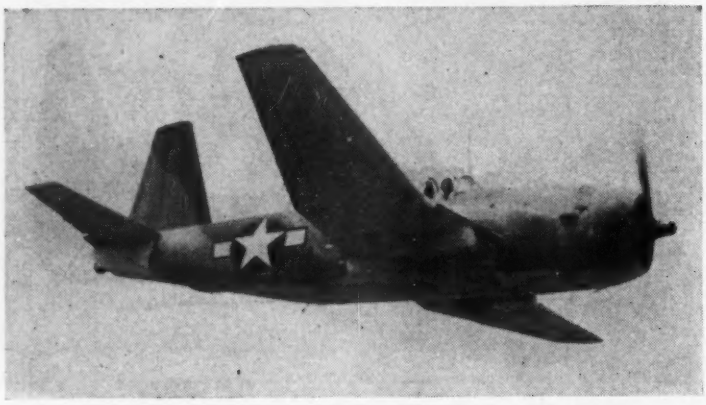


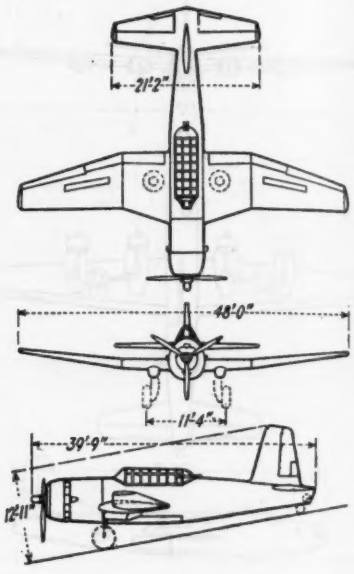


Consolidated Vultee PB2Y-3 Coronado

Armament, minimum of six 50-cal. machine guns, gross weight, 66,000 lb., high speed, 200 mi. plus; range, over 3,500 mi., service ceiling, 20,800 ft. Powered by four 1,200 hp. P & W's. Has served both as patrol bomber and as cargo carrier with Naval Air Transport Service throughout Pacific.

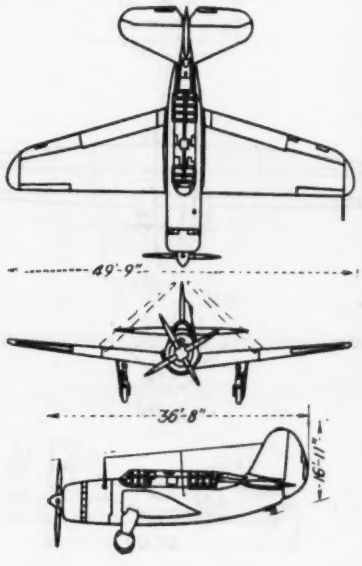
AMERICAN BOMBERS





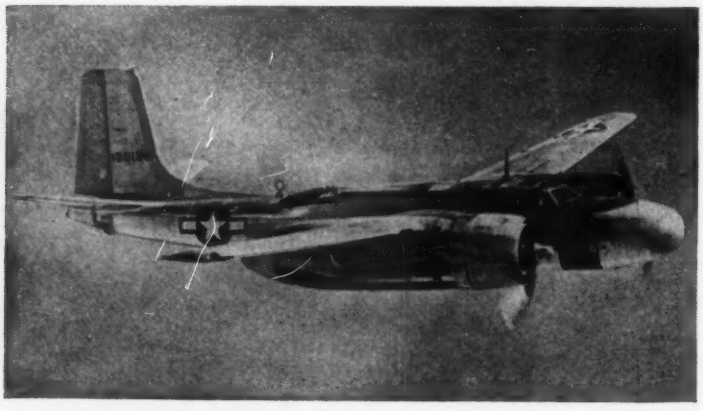
Consolidated Vultee A-35 Vengeance

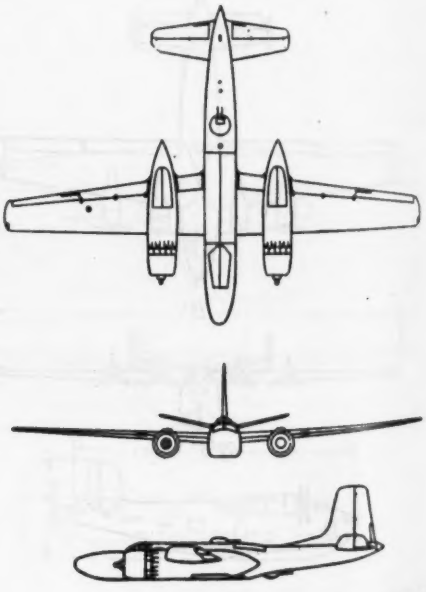
All-metal low mid-wing dive bomber produced for British in 1940. High speed, over 250 mph., range, 1,500 mi. plus. Powered by one 1,700-hp. Wright Cyclone 14. Slatted dive brakes fit flush with wing for normal flight, swing out from both surfaces to slow speeds in dive approaching the target.



Curtiss SB2C Helldiver

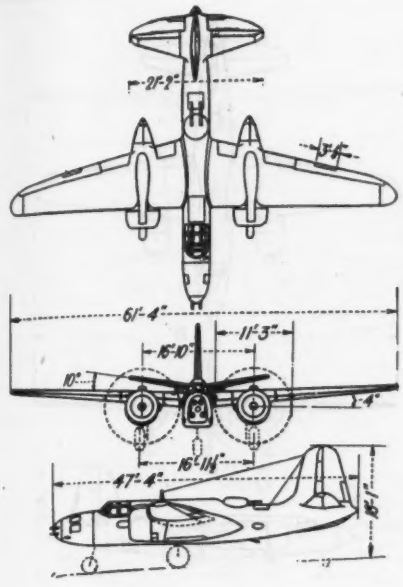
Armament, machine guns or 20 mm. cannon in wing and twin 50's in rear cockpit; high speed, over 300 mph., cruising speed, 250 mph., range, 1,200 mi., service ceiling, 25,000 ft., bomb load of approximately 1,800 lb. carried within fuselage. Powered by one 1,700-hp. Wright 14. Photo shows Army A-25 version.





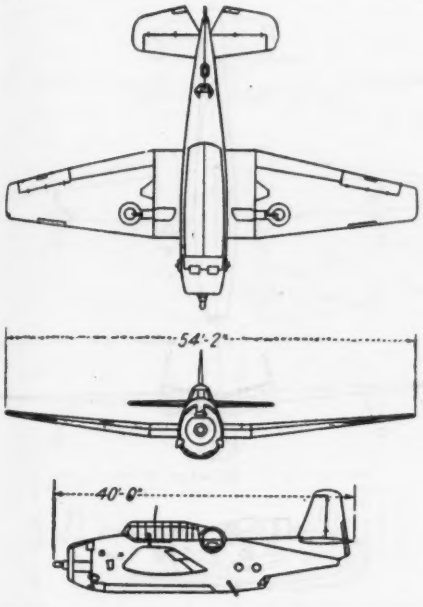
Douglas A-26B Invader

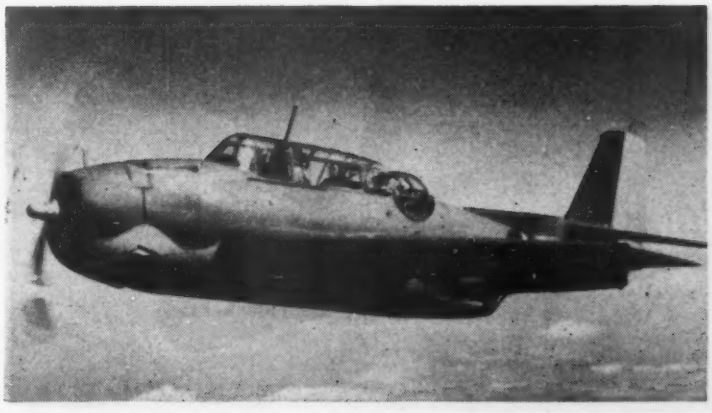
Said to be one of world's most versatile planes. Armament can be varied according to operations; bomb loads are said to be unusually heavy for craft of its size. High speed, over 375 mph., gross weight, 26,000 lb. plus. Powered by two 2,000-hp. Pratt & Whitneys. A battle-development of famed A-20.



Douglas A-20 Havoc

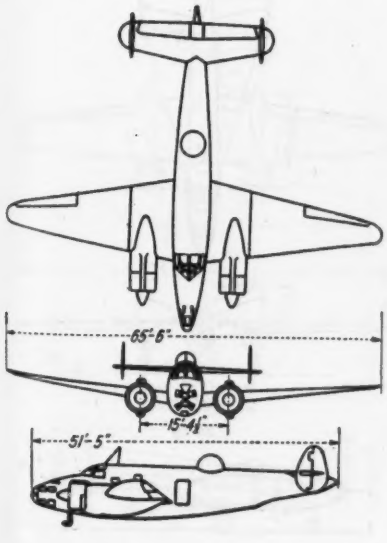
Forward armament varies between 50-cal. machine guns and 20 mm. cannon—or combinations—and 50's are used in rear turret. High speed, over 350 mph., gross weight, 20,000 lb., range, 1,050 mi., service ceiling, 20,000 ft. Powered by two 1,825-hp. Wright R-2600 Cyclone 14's. Also serving RAF.

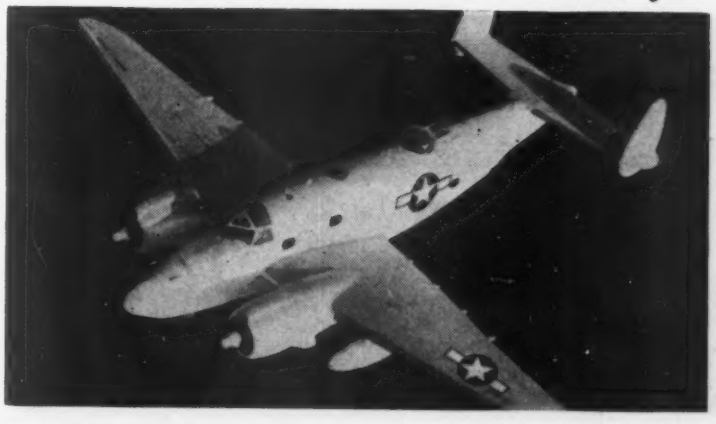




Grumman TBF Avenger

Armament, multiple 50-cal. machine guns firing forward, power dorsal turret, and ventral gun tunnel; gross weight, approximately 12,000 lb., range, 1,400 mi., high speed, about 270 mph. service ceiling, over 20,000 ft., power, 1,700-hp. Wright. Bomb load carried internally. Also serving aboard British carriers.

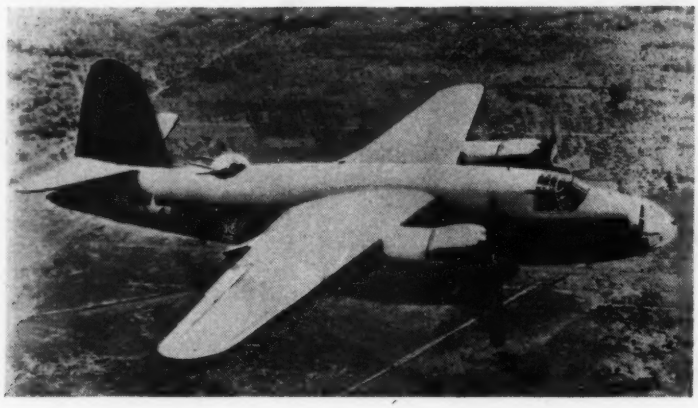


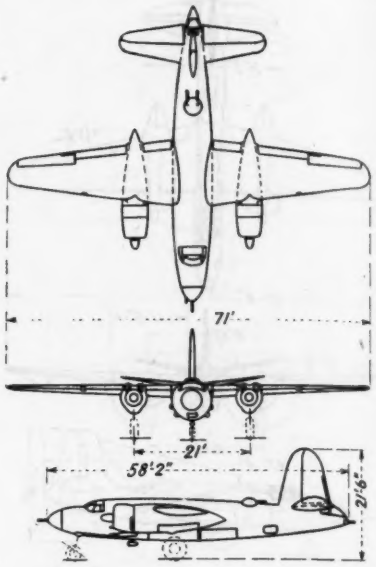


Lockheed B-34 Ventura

Armament, 50-cal. machine guns in nose, power dorsal turret and ventral tunnel; gross weight, 30,000 lb., range, 1,350 mi., high speed, 248 mph., service ceiling, 30,000 ft., power plant, two 2,000-hp. R-2800 P & W's. Also used extensively by Navy on coastal patrol work under PV-1 designation.

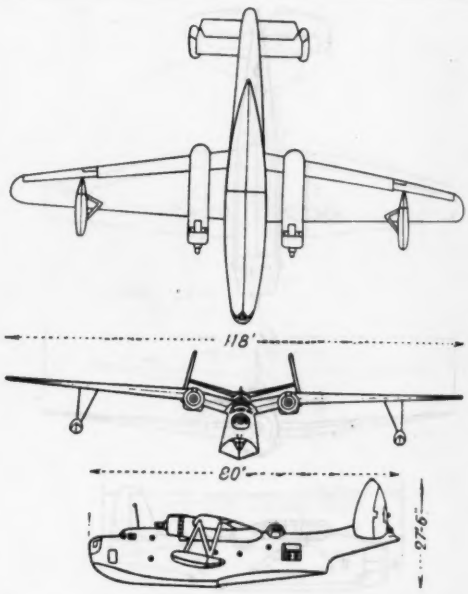
AMERICAN BOMBERS





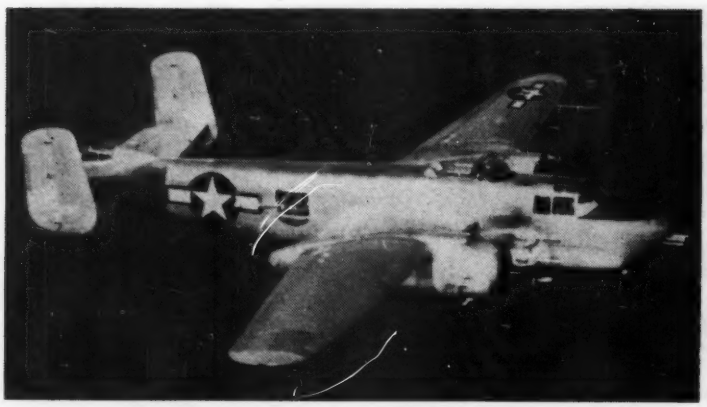
Martin B-26G Marauder

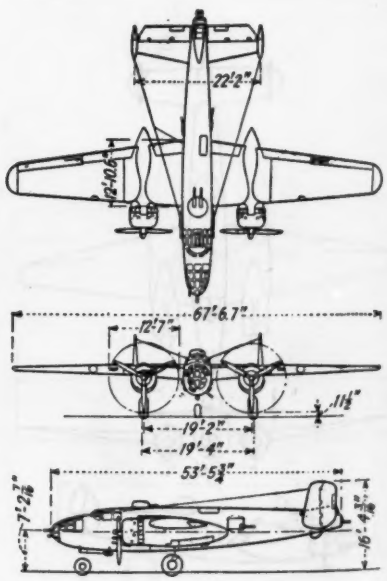
One of world's heaviest armed medium bombers. Gross weight, 35,000 lb., range, over 1,000 mi., high speed, 326 mph., service ceiling, over 24,000 ft., powered by two 2,000-hp. R-2800 Pratt & Whitneys. In addition to all types of land operations, has also served as torpedo bomber in Pacific theatre of operations.



Martin PBM-3R Mariner

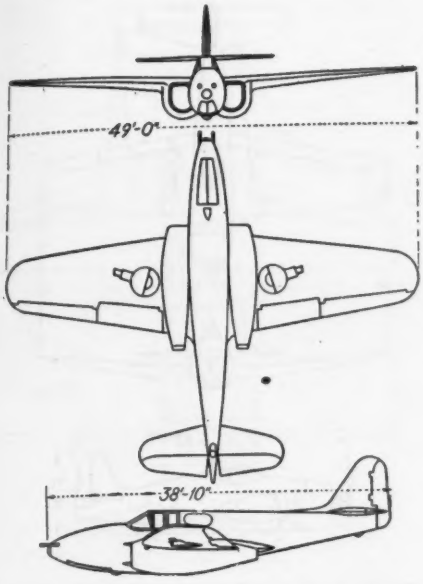
Armament, 50-cal. machine guns in nose, dorsal and tail turrets; gross weight, 56,000 lb., range, over 3,000 mi., high speed, 220 mph., service ceiling, over 15,000 ft., powered by two 1,700-hp. Wright Cyclones. Also widely used as cargo carrier under PBM-5 designation. Bomber carries crew of 9-12.





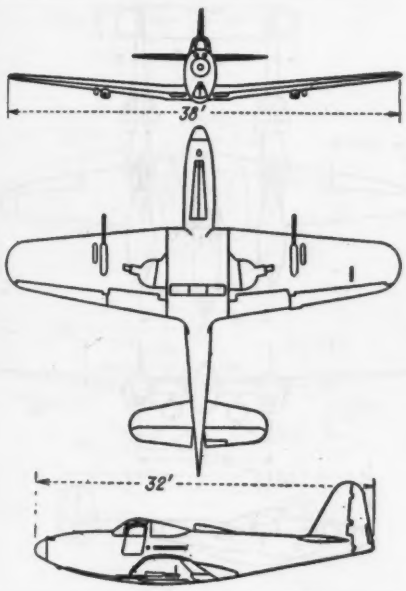
North American B-25J Mitchell

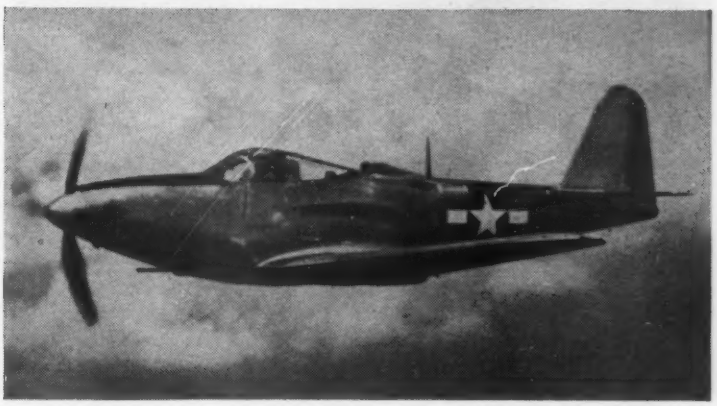
Armament ranges up to 14 50-cal. machine guns and one 75 mm. cannon besides bomb load. Gross weight, 27,000 lb., weight empty, 19,480 lb., high speed, over 300 mph. at 14,500 ft., service ceiling, 25,500 ft. Powered by two 1,700-hp. R-2600 Wright Cyclone 14's. Cannon version also used by Marines.



Bell P-59A Airacomet

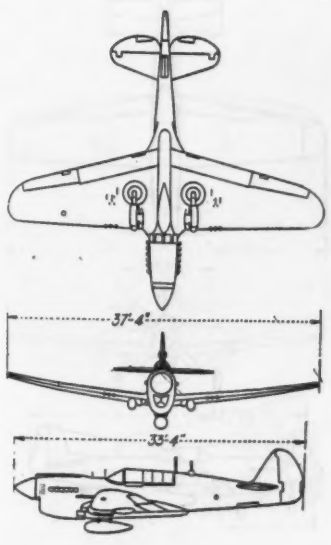
America's first jet-propelled plane, this fighter is powered by two Whittle-type gas turbines developed and produced by General Electric. All performance data is restricted, but speed is in excess of 400 mph. Ceiling is over 40,000 ft. Armament consists of at least four 50-cal. machine guns.

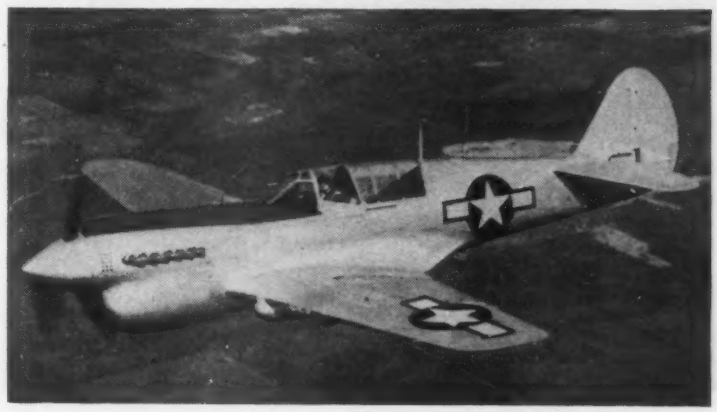




Bell P-63 Kingcobra

Armament, 37 mm. cannon firing through propeller hub, and four 50-cal. machine guns; gross weight, 8,150 lb., range, over 1,000 mi., high speed, 400 mph. plus, service ceiling, 35,000 ft. Powered by 1,500-hp. Allison 1710. Developed from P-39 Airacobra. Large part of production has gone to Russia.

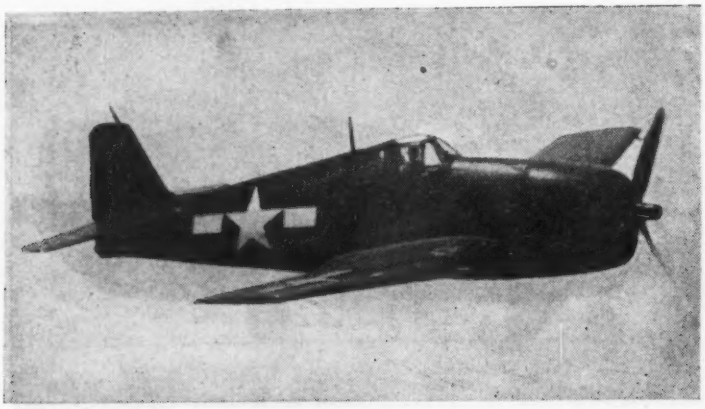


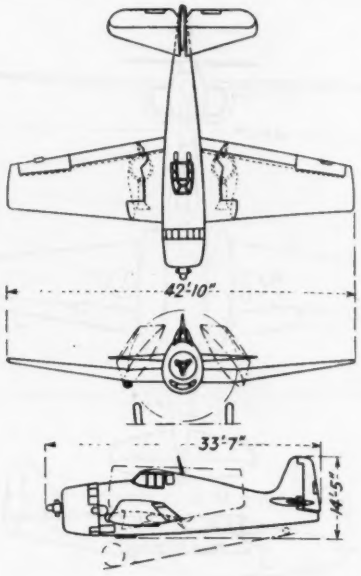


Curtiss P-40N Warhawk

Armament, six 50-cal. machine guns; gross weight, 9,000 lb., range, 1,000 mi., high speed, over 350 mph., cruising speed, 300 mph., service ceiling, 35,000 ft. Powerplant, 1,395-hp. Allison V-1710. Model Q, last of this famous line, has Packard-built Rolls Royce. C-W has built 15,000 of P-40 series.

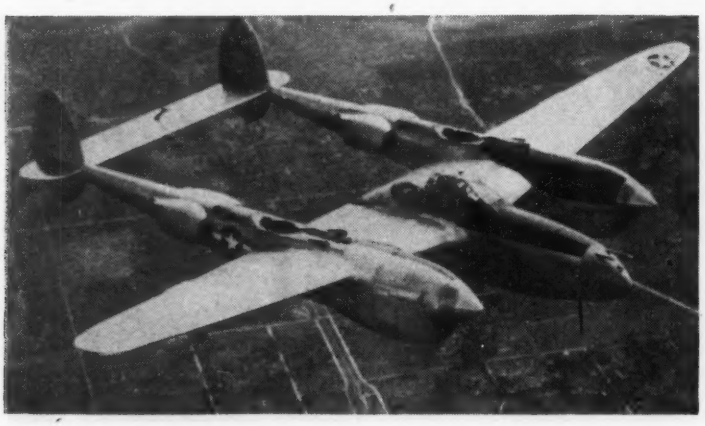
AMERICAN FIGHTERS

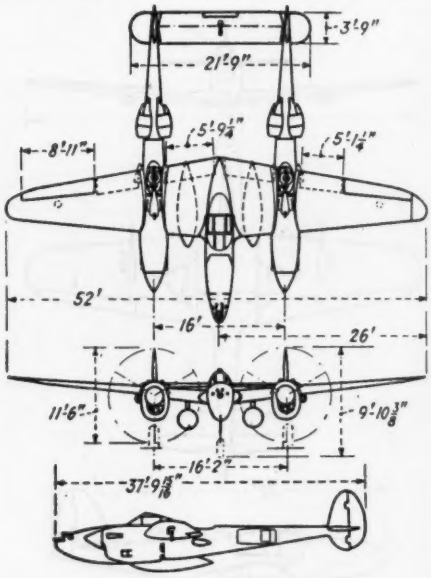




Grumman F6F-5 Hellcat

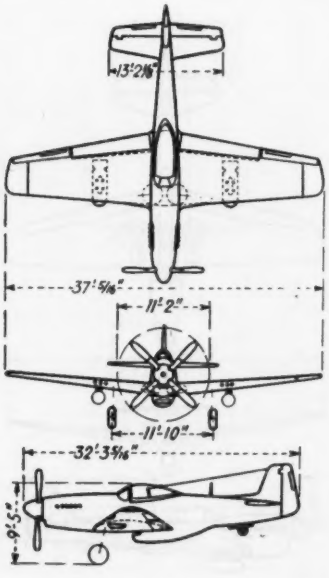
Armament, six 50-cal. machine guns in wings; gross weight, approximately 7,000 lb., high speed, over 380 mph., service ceiling, 35,000 ft. Powered by 2,000-hp. Pratt & Whitney R-2800. Drop tanks give range of 1,500 mi. First carrier fighter to be designed on basis of combat experience.





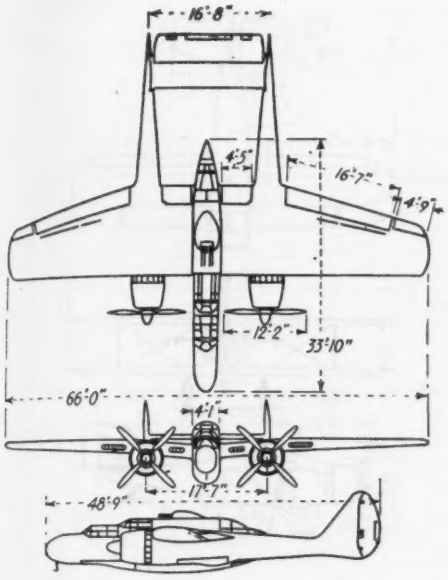
Lockheed P-38J Lightning

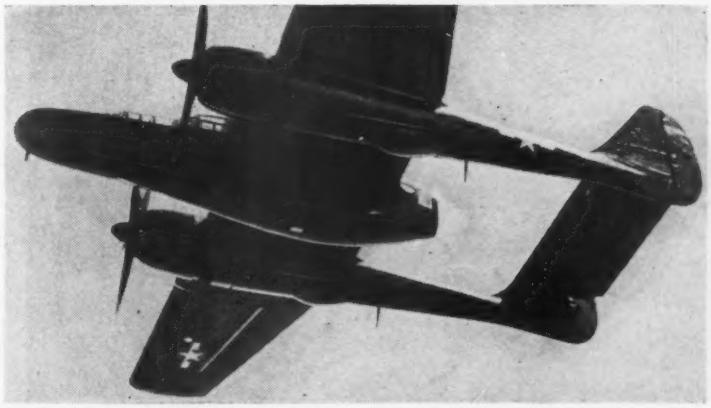
Armament, four-50's and one 20-mm. cannon mounted in nose; gross weight, up to 18,000 lb., weight empty, 12,700 lb., range, 750 mi., high speed, over 400 mph., service ceiling, 35,000 ft. plus. Powered by two V-1710 turbo-supercharged Allisons giving 1,520 hp. to 27,000 ft. Photo-reconn version designated F-5.



North American P-51D Mustang

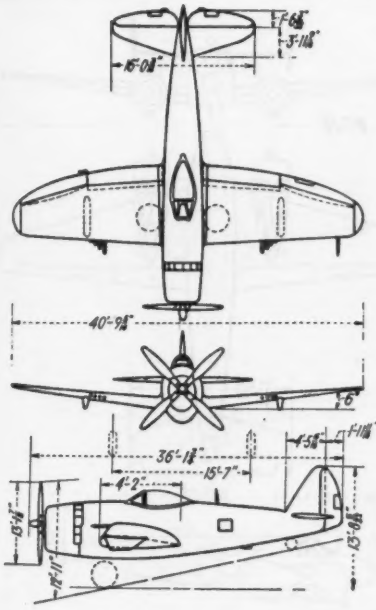
Armament, six 50-cal. machine guns or four 20 mm. cannon, or combinations; gross weight, 8,-604 lb., high speed, over 450 mph., service ceiling, 40,000 ft. plus; power plant, Packard-built Rolls Royce Merlin delivering 1,600 hp. at 11,800 ft. One of the world's top fighters, it has doubled as dive-bomber.

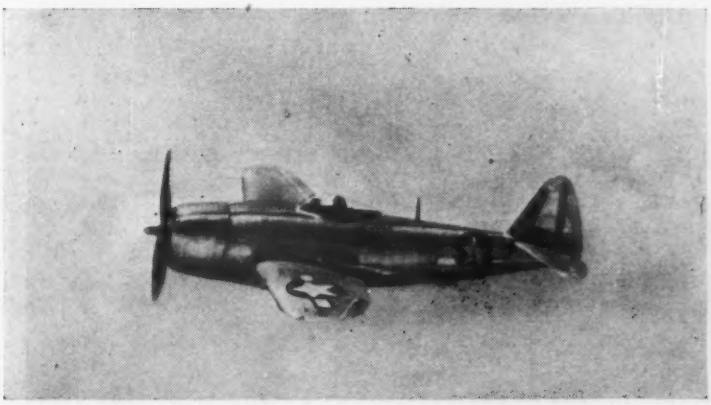




Northrop P-61 Black Widow

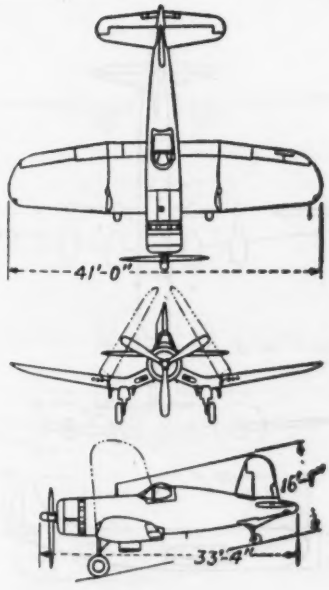
Four 50-cal. machine guns in power turret, undisclosed number of 20 mm. cannon make this night fighter one of heaviest armed of such craft. Gross weight 26,000 lb., high speed over 350 mph., landing speed, 90 mph. but can be flown at less. Power, two 2-000-hp. plus Pratt & Whitney Double Wasps.

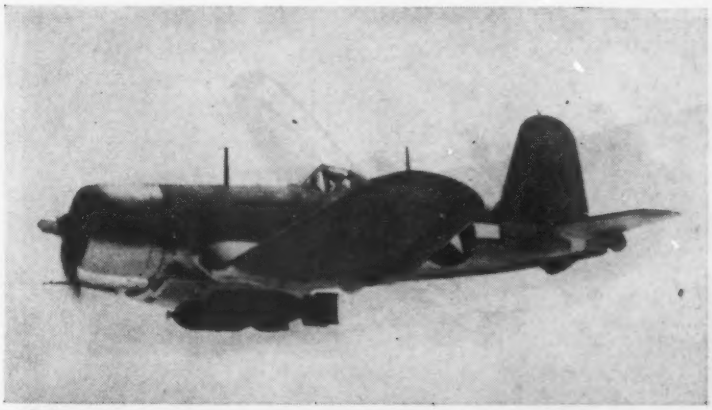




Republic P-47D Thunderbolt

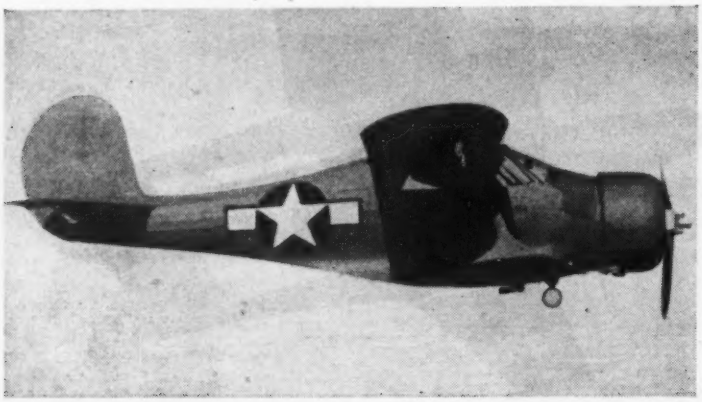
Armament, eight 50-cal. machine guns; gross weight, over 14,000 lb., range, 1,000 mi., high speed, over 430 mph. at 25,000 ft., service ceiling, 35,000 ft. Powered by turbo-supercharged R-2800 Pratt & Whitney two row radial, water injection engine of over 2,000 hp. Has doubled as dive bomber and ground strafer.

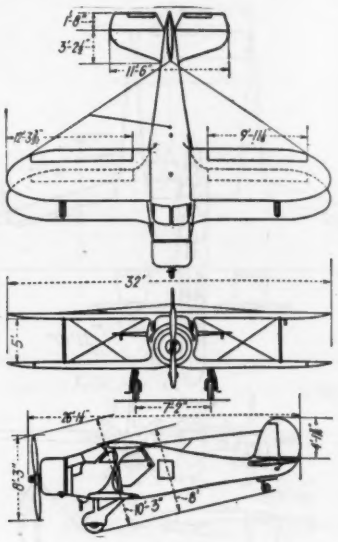




Vought F4U-1D Corsair

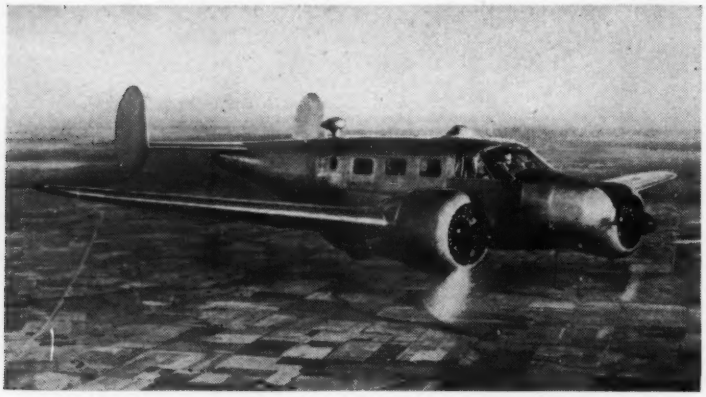
Armament, six 50-cal. machine guns; range, 1,500 mi., high speed, over 400 mph., service ceiling, over 35,000 ft. Powered by 2,000-hp. Pratt & Whitney R-2800 Double Wasp. Used as both land- and carrier-based fighter. Also produced by Goodyear Aircraft Corp. as FG-1. Doubles as bomber.

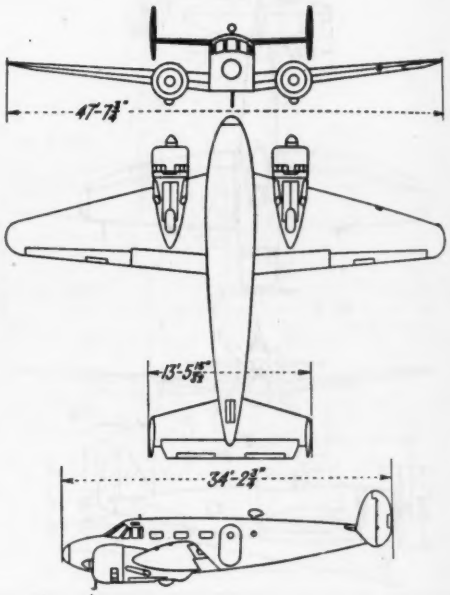




Beech UC-43 Traveler

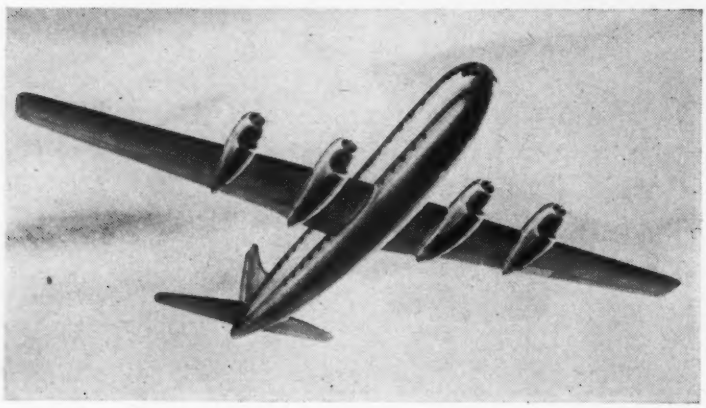
Popular prewar personal craft put into military service as personnel carrier where swift movement is necessary. High speed, 203 mph. at 5,000 ft., cruising speed, 171 mph. at 5,000 ft., range, 525 mi., service ceiling, 24,300 ft. Powered by one 450-hp. Pratt & Whitney, some produced with 300-hp. Jacobs L-6.

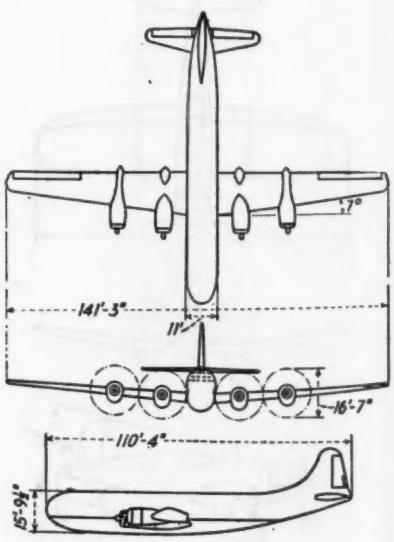




Beech UC-45A Expediter

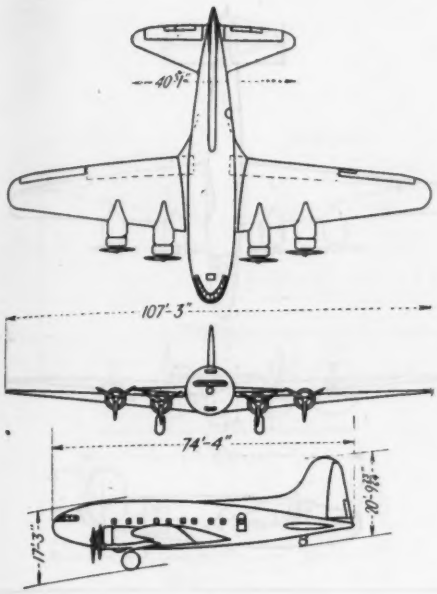
Military version of type to be modified for postwar feeder line operations with five to six passenger capacity. High speed, 223 mph., cruising speed, 194 mph., gross weight, 7,500 lb., weight empty, 5,025 lb., service ceiling, 27,000 ft., initial rate of climb, 1,850 fpm. Powered by two 450-hp. P & W's.

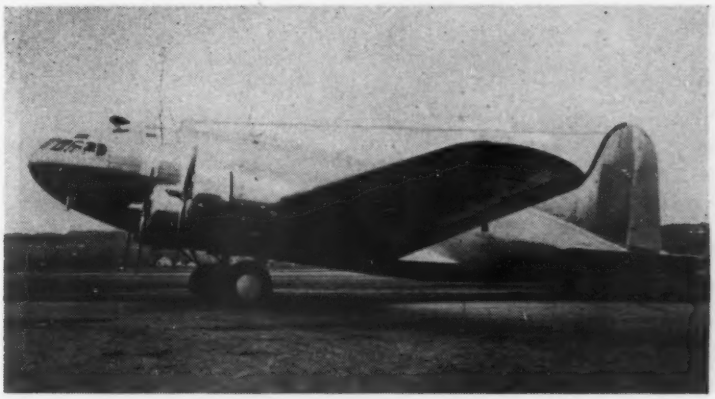




Boeing C-97 Stratocruiser

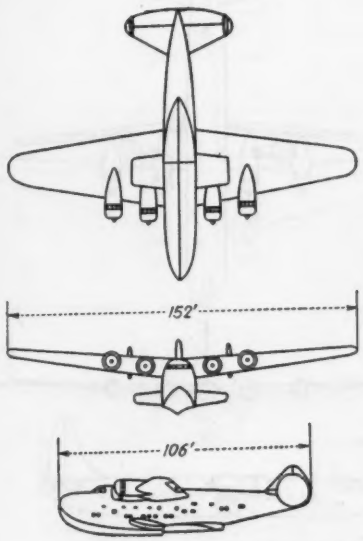
Postwar transport based on B-29 Superfortress design, with passenger capacity ranging from 70 to 100. High speed, 400 mph., cruising speed, 340 mph., gross weight, 130,000 lb., weight empty, 70,000 lb., normal range, about 3,500 mi. Power, four 2,200 hp. Wrights. Set cross-country record of 6 hr. 4 min.

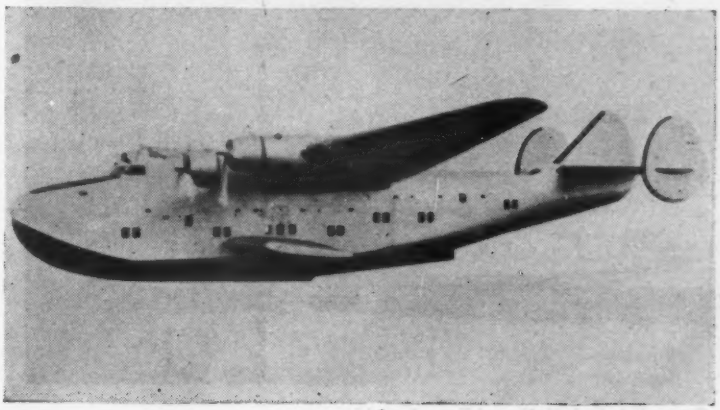




Boeing SA 307B-1 Stratoliner

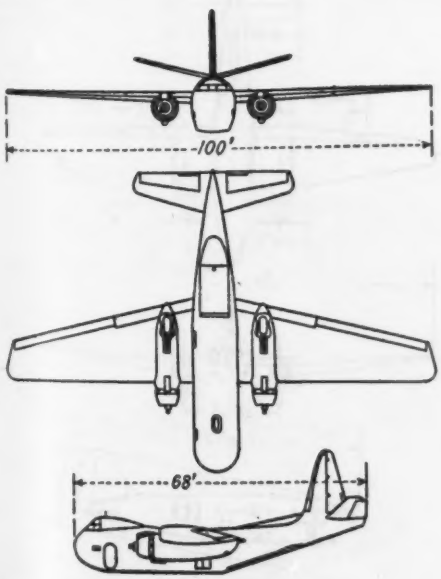
Famed prewar luxury liners being rebuilt for TWA, using B-17 wings, powerplants, landing gear and tail surfaces. High speed 255 mph. at 15,000 ft., cruising, 225 mph. at 15,000 ft., service ceiling, 22,000 ft., range 1,500 mi., gross weight, 54,000 lb. Power, four 1,200-hp. Wright Cyclone nine's.

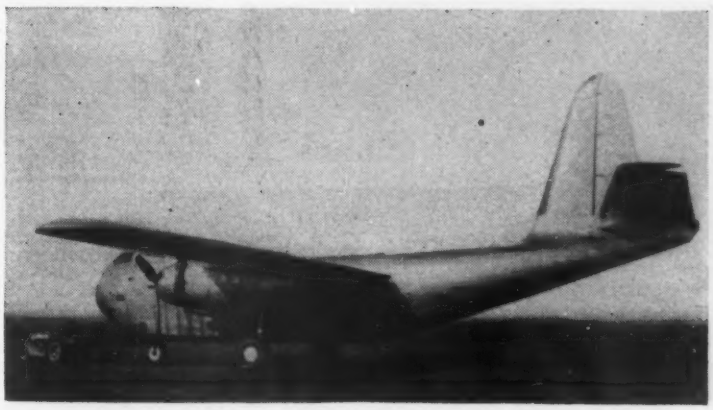




Boeing 314 Clipper

Trans-ocean flying boats serving Panam and Government-operated British Overseas Airways in worldwide operations. High speed, 210 mph., cruising speed, 188 mph., range, 4,900 mi., gross weight, 84,000 lb., weight empty, 49,149 lb. Maximum load, 89 passengers. Power, four 1,600-hp. Wright Cyclones.

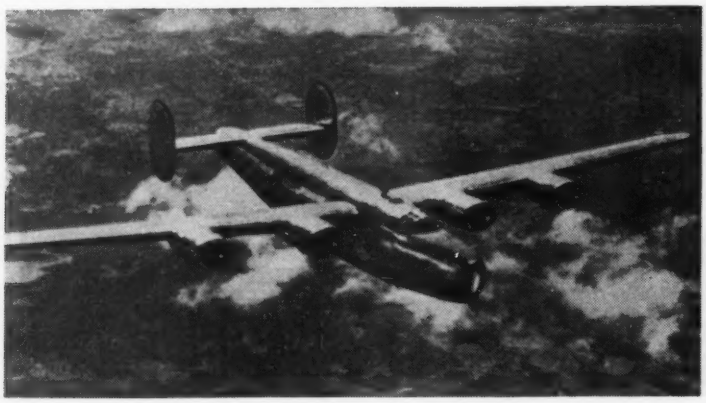


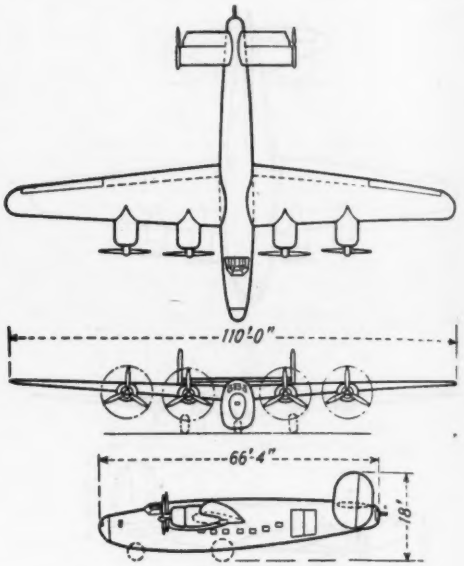


Budd RB-1 Conestoga

Welded stainless steel cargo carrier with 8 x 8 by 25-ft. unobstructed space within fuselage; rear loading door. Designed to take off with full load in 920 ft. Gross weight, 33,800 lb., payload, 10,400 lb., cruising speed, 165 mi., normal range, 600 mi., maximum range, 1,700 mi. Power, two 1,200 hp. P&W's.

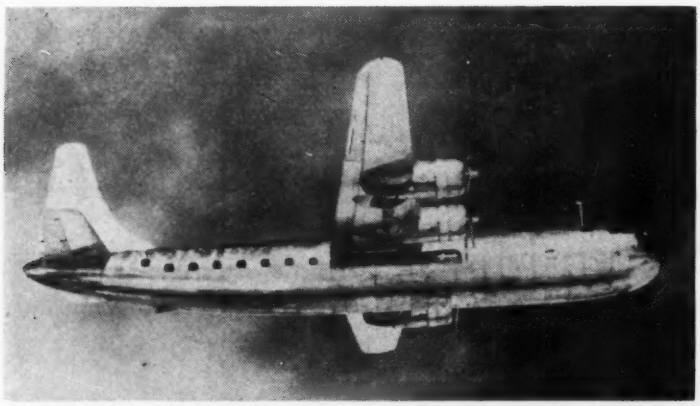
AMERICAN TRANSPORT

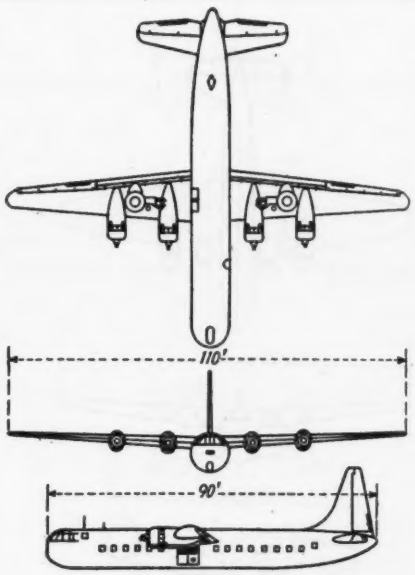




Consolidated Vultee C-87 Liberator Express

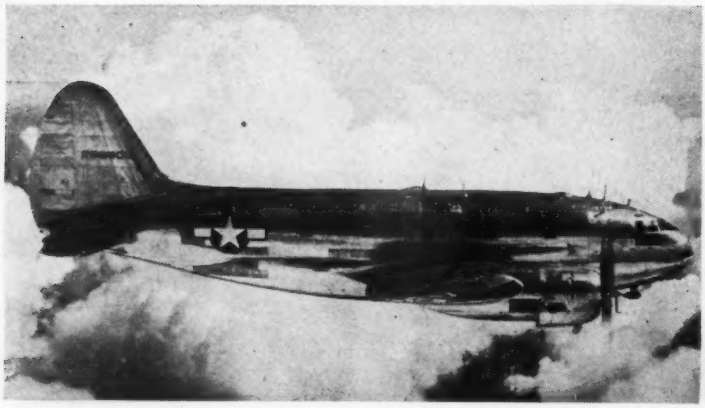
Military cargo-passenger transport version of B-24, used extensively on Burma-China run over Himalayan "Hump." High speed, over 320 mph., cruising speed, over 200 mph., gross weight, over 60,000 lb., range, approximately 4,000 mi. Powered by four turbo-supercharged 1,200-hp. Pratt & Whitneys.

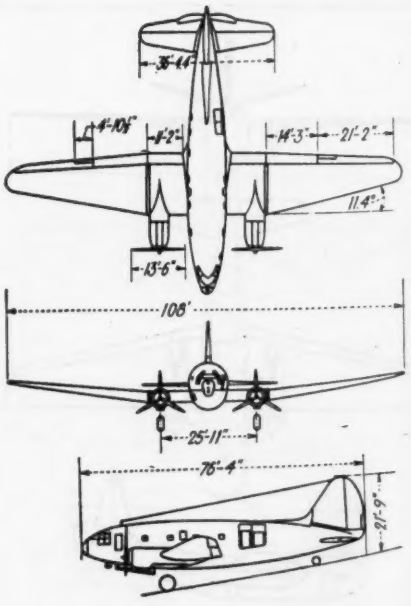




Consolidated Vultee Liberator Liner

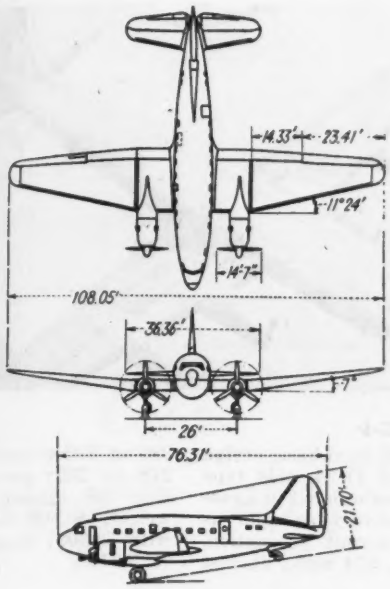
Of 48-52 passenger capacity, this liner is built around B-24 wing, power plant and landing gear. High speed, over 266 mph. at 13,500 ft., cruising speed, over 200 mph. at 10,000 ft., gross weight, 64,000 lb., weight empty, 30,928 lb., maximum range, over 3,000 mi. Power, four 1,350-hp. P & W's.

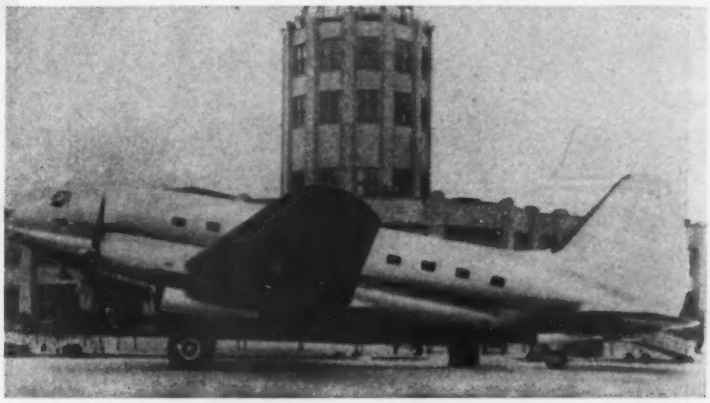




Curtiss C-46 Commando

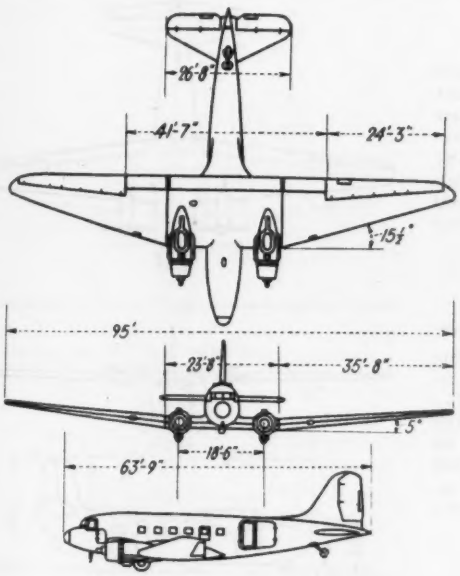
World's largest twin engine transport, used in every war theatre. High speed, over 265 mph. at 13,000 ft., cruising speed, 227 at 10,000 ft., service ceiling, 24,500 ft., range, 1,500 mi., gross weight, 48,000 lb., weight empty, 29,438 lb. Power, two 2,000-hp R-2800 Pratt & Whitney Double Wasps.





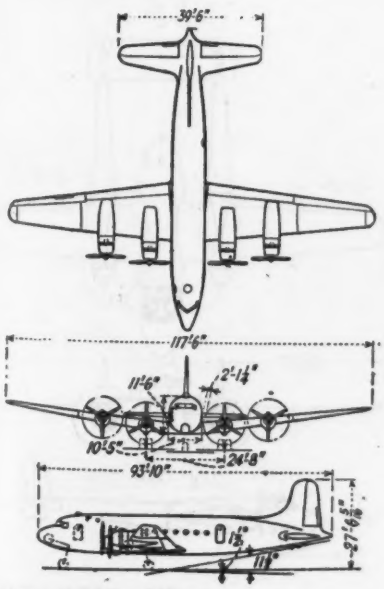
Curtiss CW-20E Commando

Postwar commercial version of C-46, seating 36-42 passengers, on which Eastern and National have placed orders. Re-designed nose and pilot's cabin is major outward change, but others have been made throughout to adapt plane to peacetime operations on airlines. New version to be powered by 2,200-hp. Wrights.



Douglas C-47 Skytrain

Military version of famed DC-3; most widely used transport in world. High speed, 230 mph. at 8,500 ft., cruising speed, 185 mph. at 10,000 ft., service ceiling, 24,100 ft., range, over 2,000 mi., gross weight, 29,000 lb., weight empty, 16,970 lb. Power, two 1,050-hp. P & W's. Has also been used as glider tow craft.



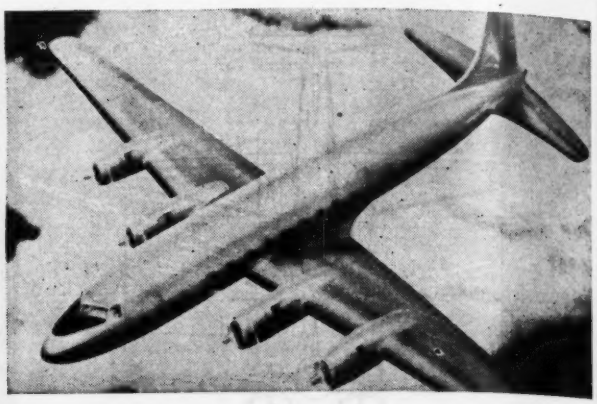
Douglas C-54 Skymaster

Widely used cargo-passenger transport familiar in every part of world. High speed, 280 mph. at 23,200 ft., cruising speed, 239 mph. at 10,000 ft., service ceiling, 26,600 ft., gross weight, 71,300 lb., weight empty, 39,000 lb. Powered by four 1,450-hp. R-2000 Pratt & Whitneys. Has range of over 3,600 miles.

AMERICAN TRANSPORT

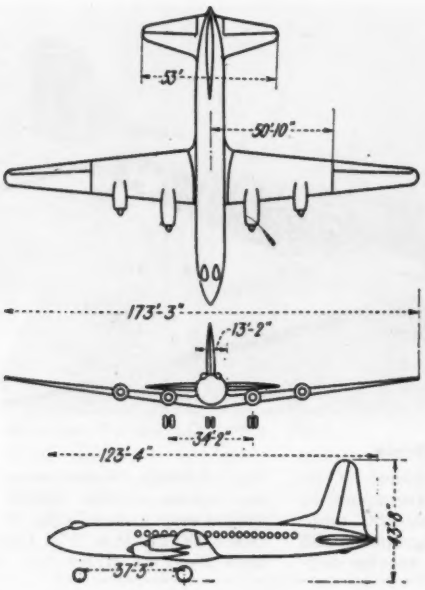
Douglas DC-4

Postwar version of famed C-54 Skymaster which will be used in trans-ocean as well as domestic operations. Several major American airlines have already placed orders on this and DC-6 types totaling more than $100,000,000. Orders call for production as soon as war conditions permit resumption of output for civilian uses.



Douglas DC-6

Developed from basic design of C-54 and DC-4, this type has also been ordered in quantity for delivery as soon as conditions permit production. High speed, 334 mph., against 280 of DC-4; cruising speed, 278 vs. 239; passenger capacity, 55 against 49; gross weight, 80,500 lb., compared with 71,300; range, 2,715 mi. vs. 3,610.



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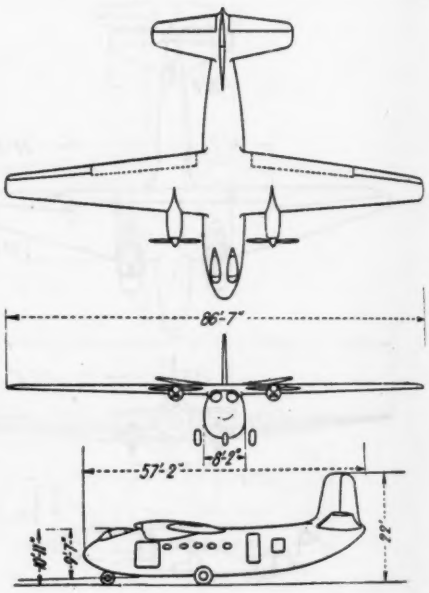
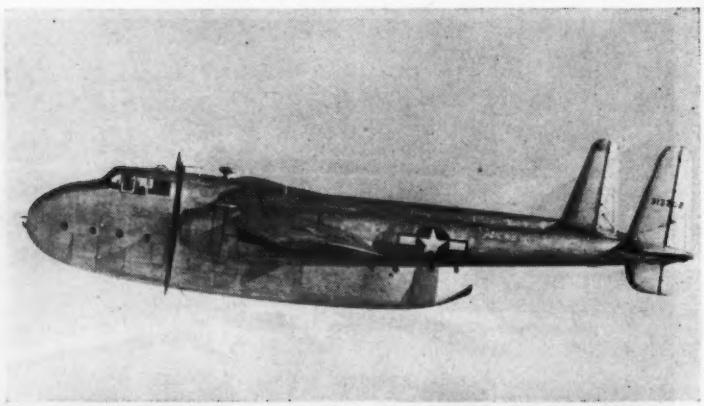
Douglas DC-7

Large postwar transport already ordered by at least one major airline. Gross weight, 162,000 lb., passenger capacity, up to 118; range, over 4,000 mi., high speed, approximately 400 mph., powerplants, four P&W Wasp Majors.

Douglas Skybus →

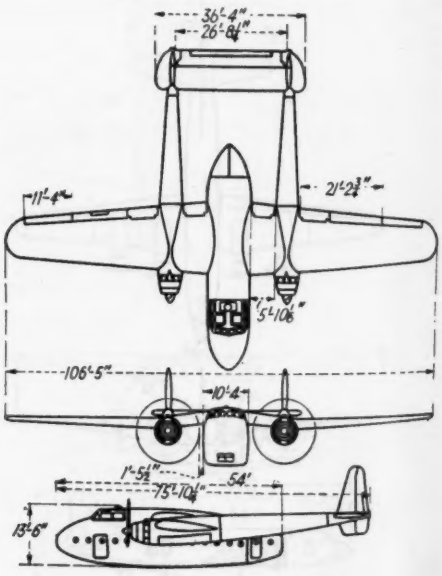
Designed for feeder line operations, seating 24 passengers. Gross weight, 17,300 lb., cruising speed, 189 mph., landing speed, 65 mph., normal range, 600 mi., wingspan, 86 ft. 7 in. Will be powered by two 700-hp. inline engines.

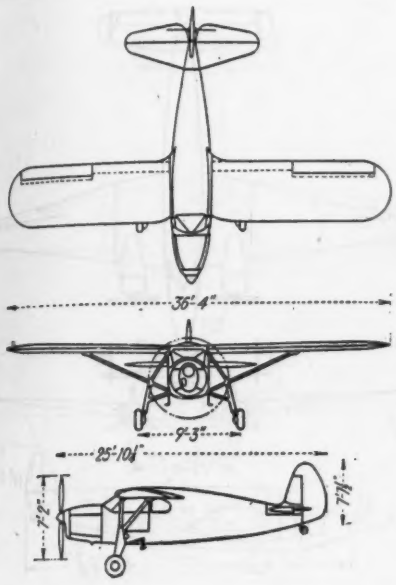


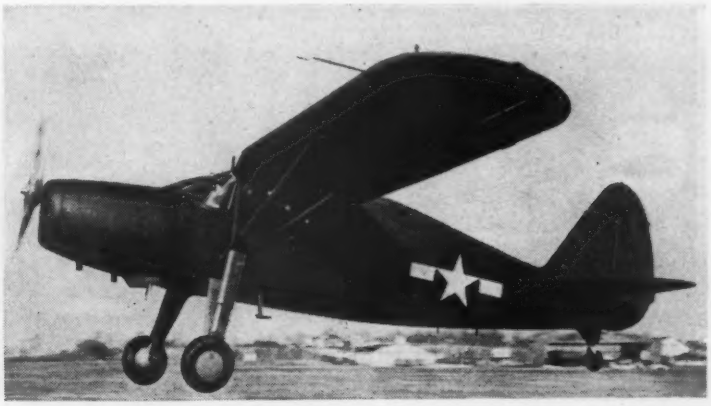


Fairchild C-82 Packet

Cargo - paratroop - ambulance craft having 2,312 cu. ft. of cargo capacity, room for 42 paratroops, or 34 litters and four attendants, plus military crew of five. Gross weight, 42,600 up to about 50,000 lb., weight empty, 26,530 lb. As liner would take 50 passengers. Power, two 2,000-hp. P & W's.

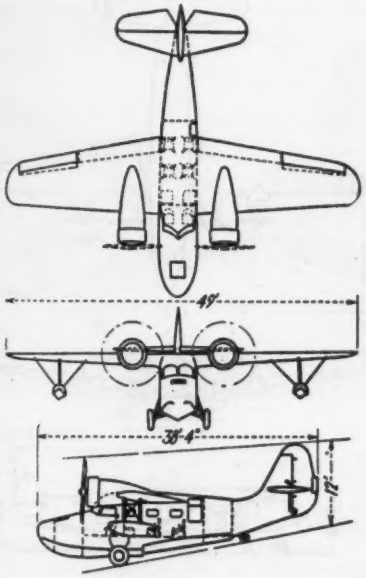






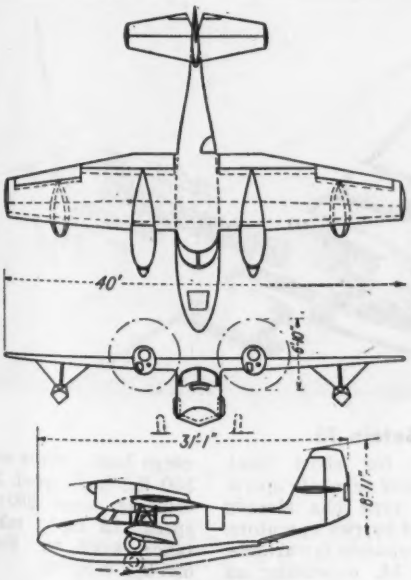
Fairchild UC-61K Forwarder

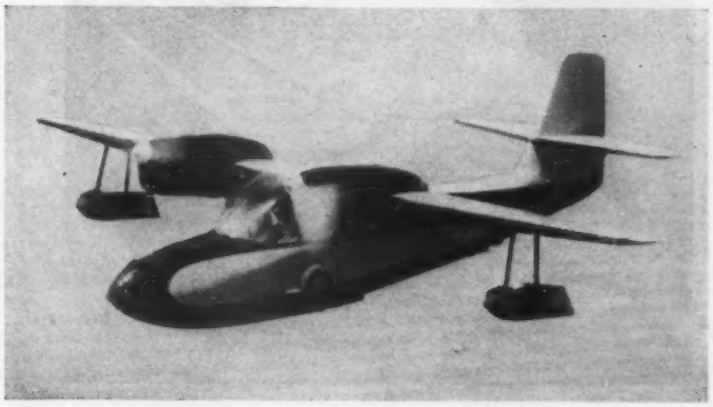
Ranger-powered military version of one of most popular personal planes. High speed, 124 mph., cruising speed, 112 mph., initial climb, 650 fpm., range 465 mph., service ceiling, 12,700 ft., gross weight, 2,882 lb., weight empty, 1,813. Engine is 200-hp. inverted six-cylinder inline. Also used by RAF, designated Argus.



Grumman JRF-6B Goose

Military version of G-21A, widely used by Coast Guard for inshore patrol and sea-rescue work. High speed, 201 mph., cruising speed, 190 mph., initial climb, 1,300 fpm., service ceiling, 22,000 ft., range, 1,000 mi., gross weight, 7,955 lb., wt. empty, 5,530 lb. Power, two 450-hp. Pratt & Whitneys.

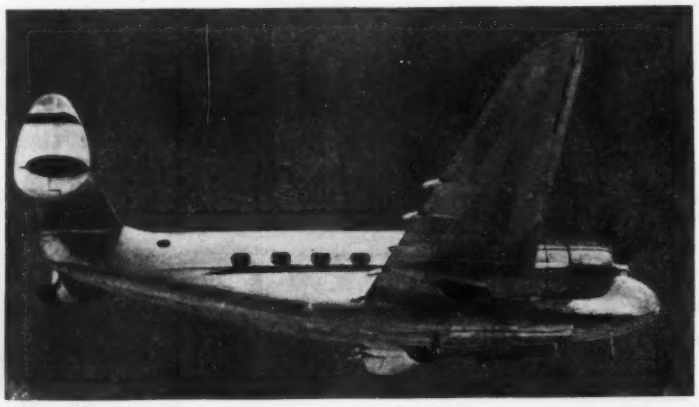


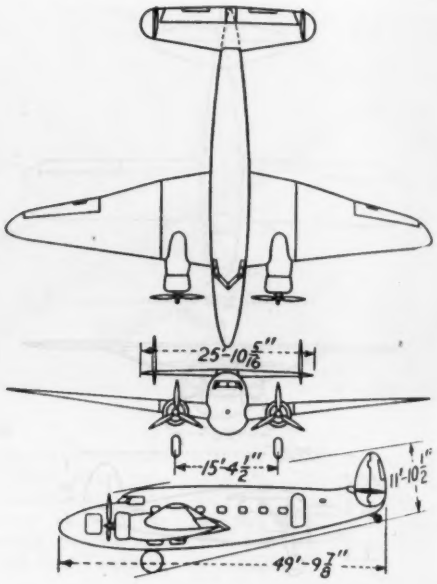


Grumman J4F Widgeon

Four-five place amphibian used extensively as personnel carrier in Navy, it is military version of popular personal plane. High speed, 164 mph., cruising speed, 150 mph., initial climb, 700 fpm., service ceiling, 15,500 ft., range, 775 mi. Power, two 200-hp. Rangers. Model pictured has peacetime color scheme.

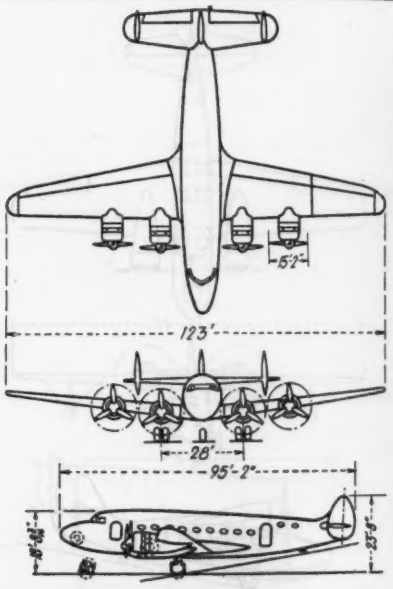
AMERICAN TRANSPORTS





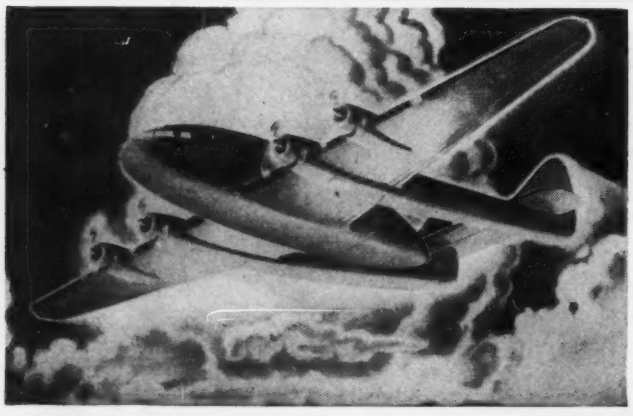
Lockheed C-60 Lodestar

A 17-place military version of prewar airliner. High speed, 276 mph., cruising speed, 248 mph., service ceiling, 27,000 ft., range, 1,540 mi., gross weight, 18,500 lb., Optional power plants are either two 1,200-hp. Pratt & Whitney Wasps or Wright Cyclones. Modifications used as navigation trainers.



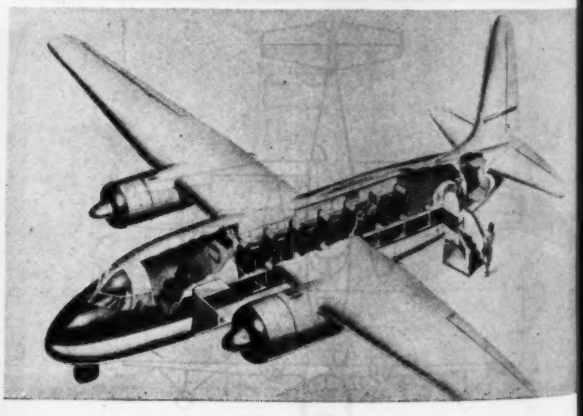
Lockheed C-69 Constellation

Designed as 60-passenger luxury liner, is now in military service. At least two airlines have orders for postwar versions. High speed over 350 mph., landing speed, 80 mph., service ceiling, 35,000 ft. gross weight 86,250 lb. Power, four 2,200-hp. Wright Cyclones. Prototype crossed country in 6 hr. 58 min.



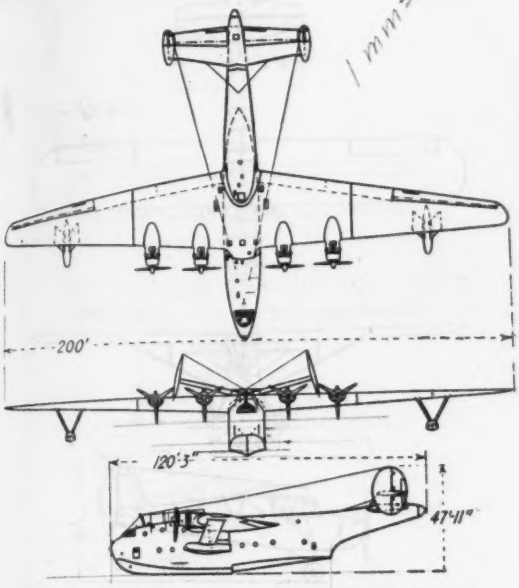
Martin van Zelm

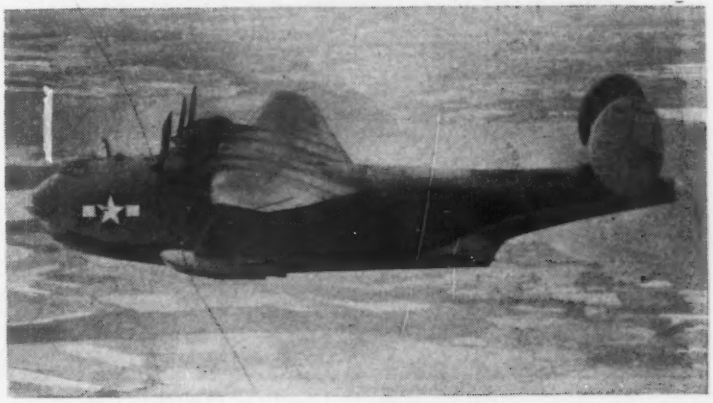
Both two and four engine designs of this type have been prepared for postwar passenger and cargo operations. Developed primarily for cargo work, both types have rear loading facilities, aft end of fuselage swinging up out of way so that trucks may back directly to craft for direct loading under booms and empennage.



Lockheed Saturn 75

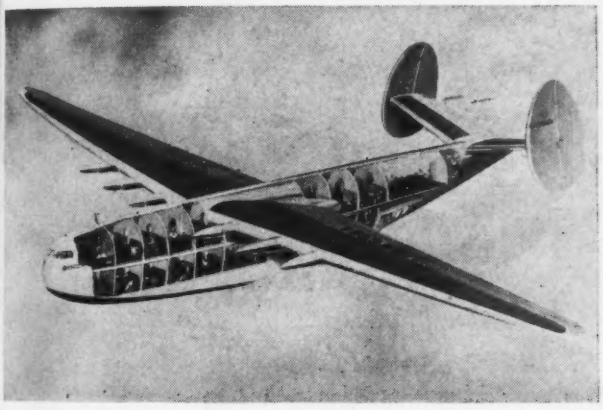
Designed for short haul, high frequency schedule operations, this type has already been ordered by two operators. Passenger capacity is variable, from 8 to 14, depending on cargo load. Gross weight 12,500 lb., high speed, 240 mph., cruising, over 200; landing speed, 73 mph., take-off distance, 1,055 ft. Power, two 525-hp. Wrights.





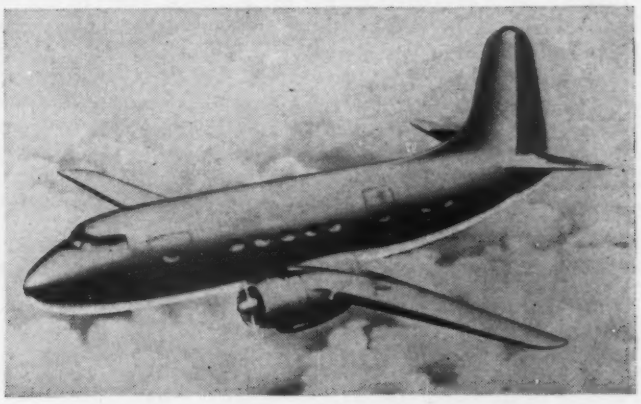
Martin JRM-1 Mars

Naval cargo version of XPB2M-1 which has consistently set new records. High speed, over 200 mph., cruising speed, in excess of 175 mph., service ceiling, over 15,000 ft., range, over 5,000 mi., gross weight, 145,000 lb. plus. Power, four 2,200-hp. Wrights. Navy's utilization, 9.7 hr. per day.



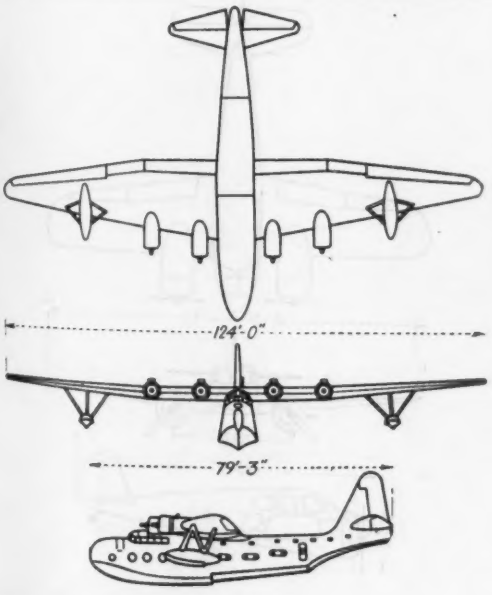
Martin Leviathan

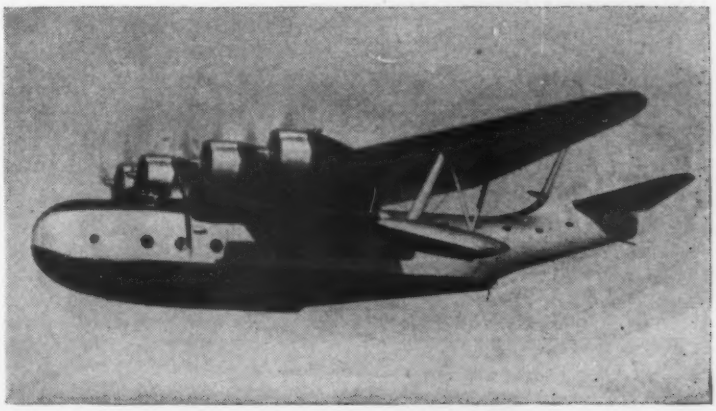
Designed for long range post-war passenger transport work, this six engine flying boat will have a gross wt. of around 250,000 lb. Passenger capacity is listed as 100, with allowances for 80 lb. of baggage each, in addition to 25,000 lb. of cargo. Designed to have cruising speed of about 200 mph. Plans also call for straight cargo version.



Martin Mercury

One version of feeder and short haul-operations craft designed to carry up to 30 passengers. Gross weight, 33,500 lb., weight empty, 22,235 lb., range, 500 mi., high speed, 311 mph. at 8,500 ft., cruising speed, 250 mph. at 10,000 ft., fuel capacity, 500 gal. Powerplants, two 2,100-hp. P & W's. Other version of same basic design has high wing.

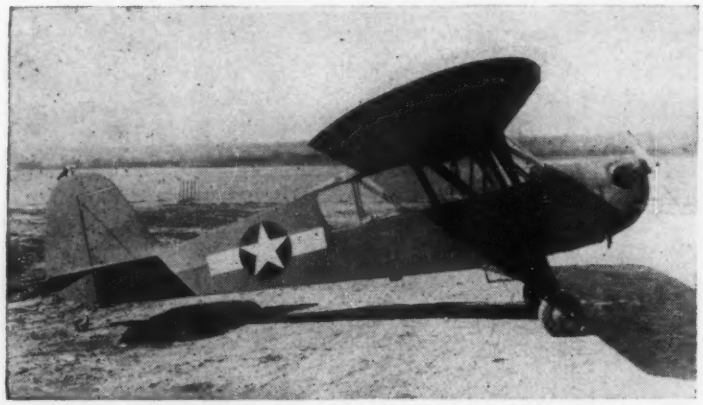


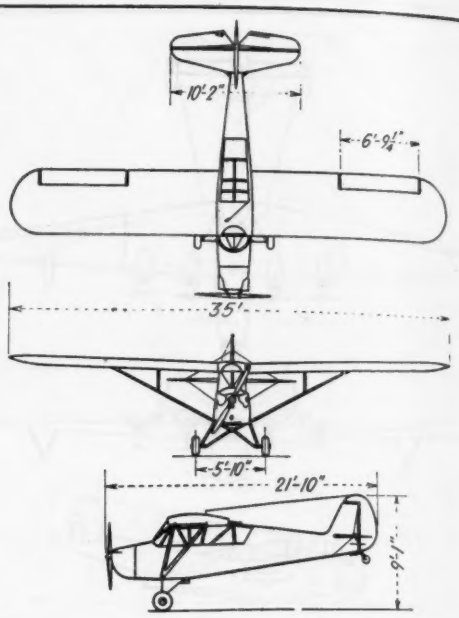


Vought-Sikorsky VS-44A Excalibur

Serving American Export Air Lines on transatlantic service, holding flying boat speed records both ways. High speed, 225 mph., cruising speed, 175 mph., service ceiling, 19,000 ft. range, 3,800 mi., gross weight, 57,500 lb., weight empty, 30,200 lb. Power, four 1,200-hp. Pratt & Whitney Twin Wasps.

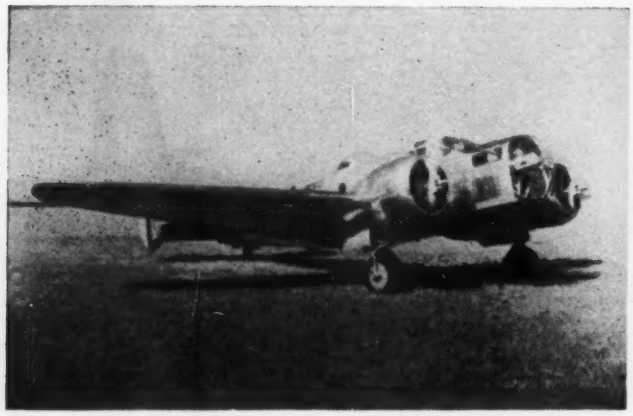
AMERICAN LIAISON TRAINERS

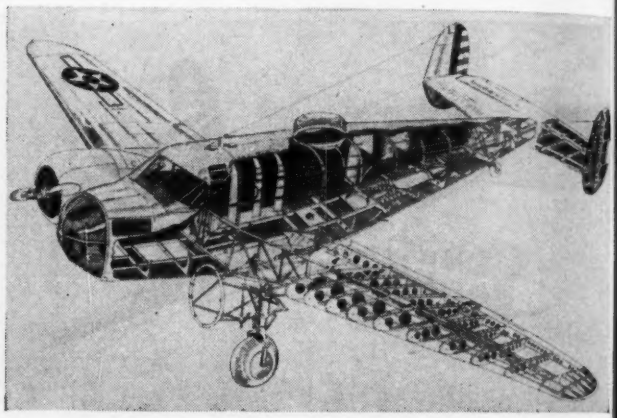




Aeronca L-3 Grasshopper

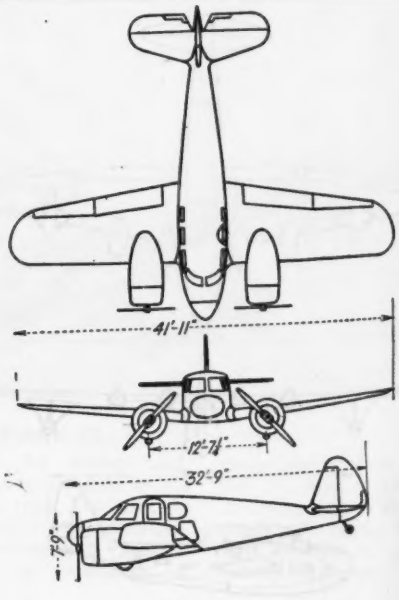
One of the "mighty mites" which have given valiant service as artillery spotters, observation and rescue planes. Developed from prewar personal plane design, has gross weight of 1,300 lb., range of 218 mi., high speed of 87 mph., cruising speed of 79 mph. and landing speed of 43 mph. Power, 65-hp. Continental.





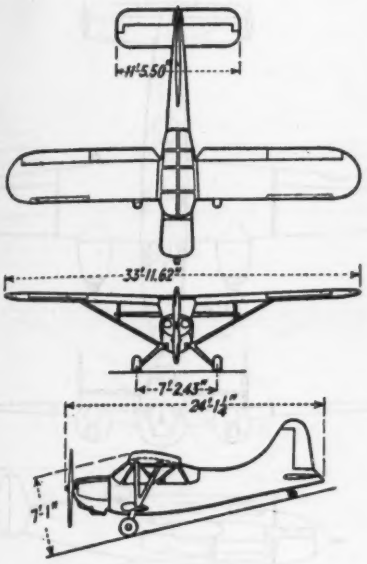
Beech AT-11 Kansas

Developed from one of Beech's well-known executive type private craft, Kansas has been widely used as a bomber crew and navigation trainer. An all-metal craft powered by two 450-hp. Pratt & Whitney Wasp Jr.'s., it has a high speed of 216 mph. at 5,000 ft., and cruising speed of 192 at same altitude. Climb at sea level is 1,125 fpm., service ceiling is 20,000 ft. Fuel capacity is 128 gals., normal range is 565 mi. Gross wt., 8,727 lb., wt. empty, 6,158. Phantom view above shows structural details and crew locations. Span is 47 ft. 8 in., length is 34 ft. 2 in., height is 9 ft. 8 in. Wing area totals 349 sq. ft., wing loading is 25 lb. sq. ft. Used by Navy as SNB-2 bomber-trainer.



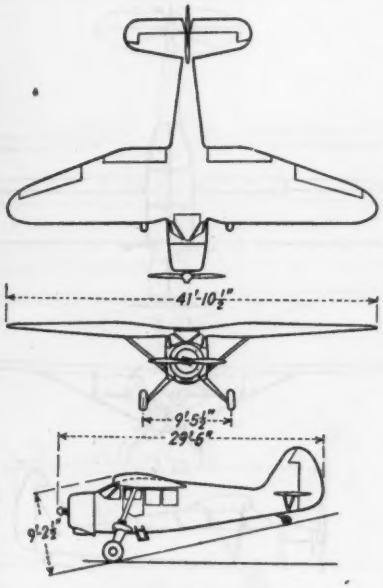
Cessna AT-17 Brasshat

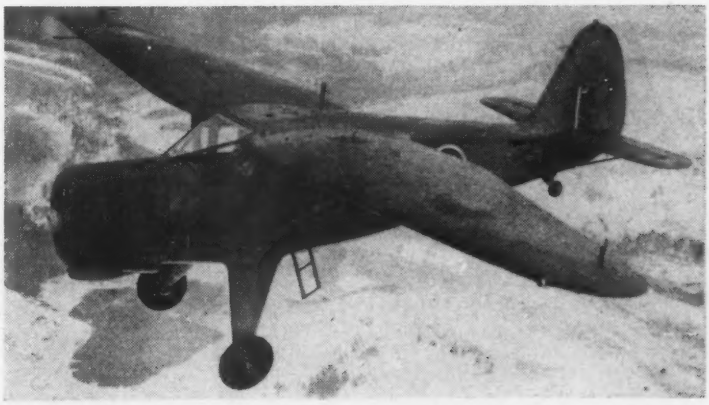
Twin engine transition trainer which has also found wide-spread use as personnel carrier by RCAF as well as American Air Forces. High speed, 185 mph., cruising speed, 165 mph., gross weight, 5,700 lb., wt. empty, 4,100 lb., range, 550 mi., service ceiling, 15,000 ft., initial climb, 950 fpm., power, two 225-hp. Jacobs.



Stinson L-5 Sentinel

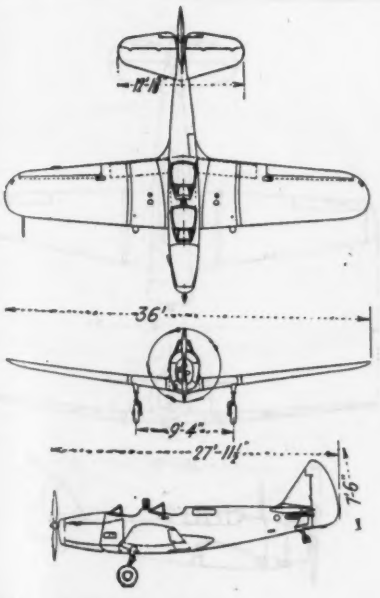
Highest powered of the L-jobs, it has a 190-hp. Lycoming engine giving a top speed of 129 mph., cruising of 117 with range of over 250 mi. Gross weight is 2,158; weight empty, 1,472 lb. Initial rate of climb is 975 fpm. and service ceiling is listed at 15,800 ft. Flaps shorten take-off run, slow landings for tough fields.

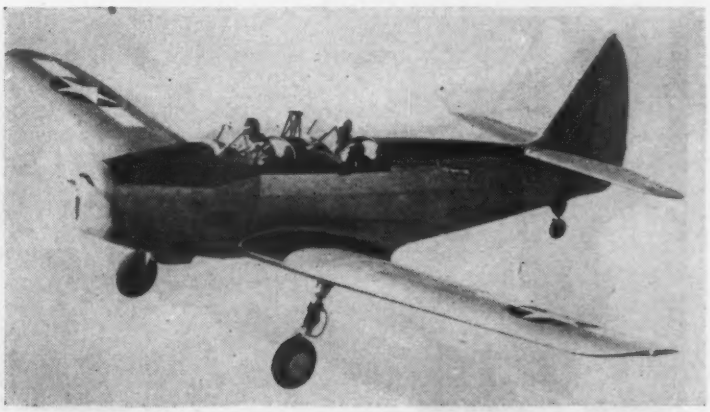




Stinson AT-19 Reliant

A favorite prewar personal plane modified for war service as advanced radio and navigational trainer widely used by RCAF and RAF. High speed, 141 mph., range 555 mi., fuel capacity 70 gals., gross weight, 4,000 lb., weight empty, 2,810 lb., service ceiling, 14,000 ft. Power, one 290-hp. Lycoming radial.

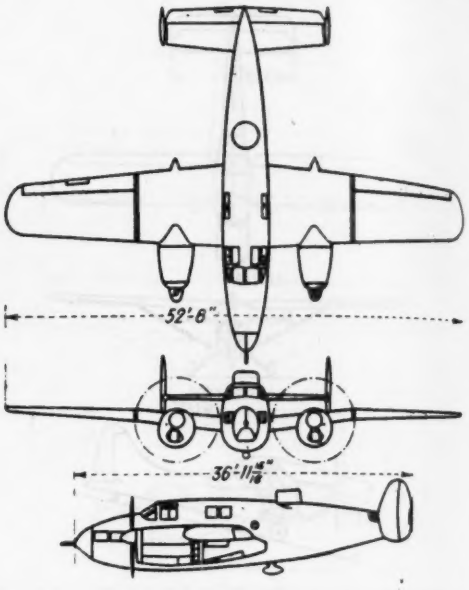




Fairchild PT-19 Cornell

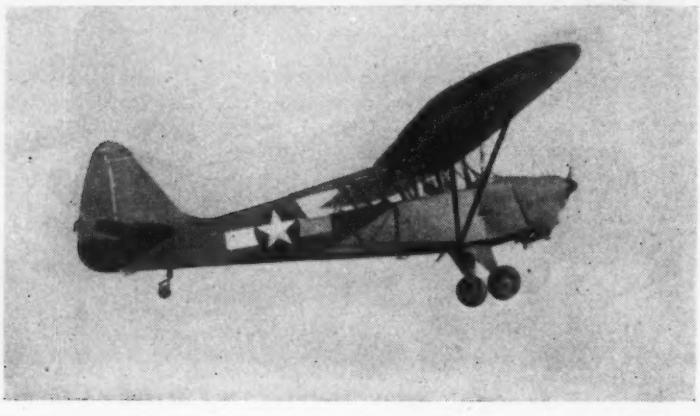
Thousands of AAF pilots have received primary training in this type, as have RCAF and RAF pilots in closed cockpit version. High speed, 125 mph., cruising speed, landing speed, 52 mph., 113 mph., range, 430 mi., gross weight, 2,518 lb., weight empty, 1,851 lb. Power, 175-hp. 6-cylinder aircooled Ranger in line.

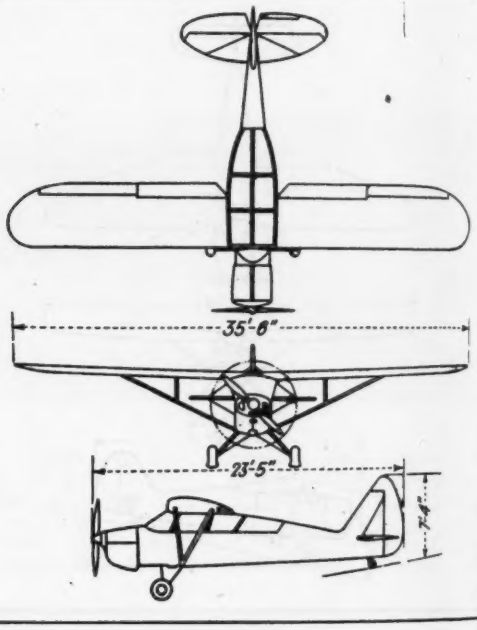
AMERICAN LIAISON-TRAINERS



Fairchild AT-21 Gunner

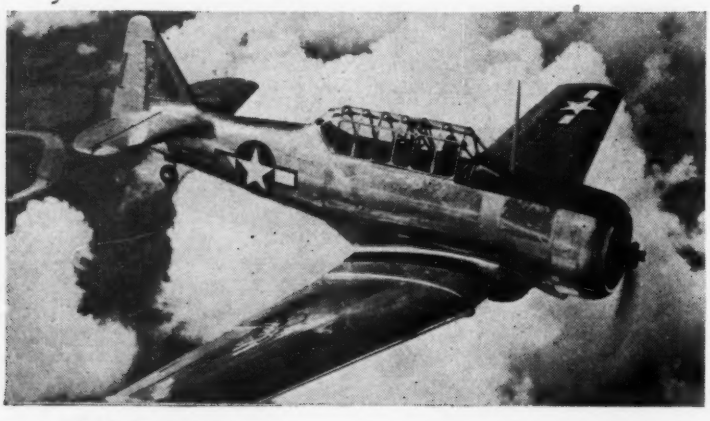
All-wood bomber crew trainer in which teamwork which has meant so much for AAF bomber record has been developed. High speed, 210 mph., cruising speed, 184 mph. Gross wt., 11,287 lb., wt. empty, 8,637 lb., normal range, 736 mi. Powered by two 12-cyl. inline aircooled 450-hp. Rangers.

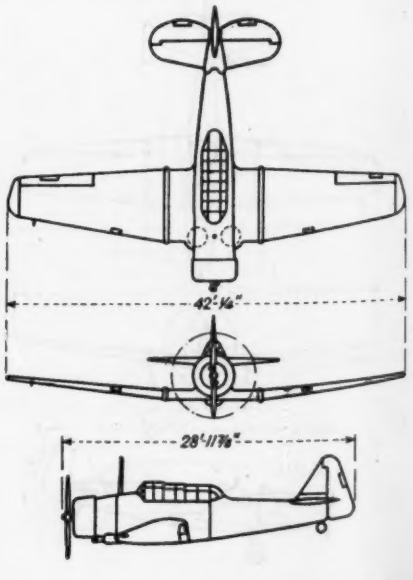




Interstate L-6

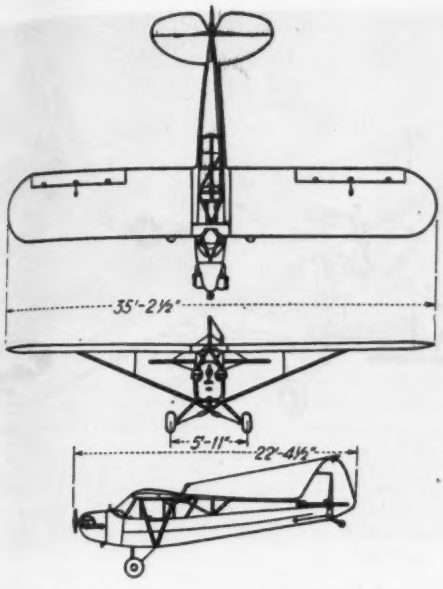
Military version of the prewar Cadet personal plane used for training liaison pilots. High speed, 114 mph. at sea level, cruising speed, 105 mph., normal range, 270 mi., fuel capacity, 20 gal., gross weight, 1,650 lb., weight empty, 1,103 lb. Landing speed, 39 mph., service ceiling, 16,500 ft. Power, one 113-hp. Franklin.

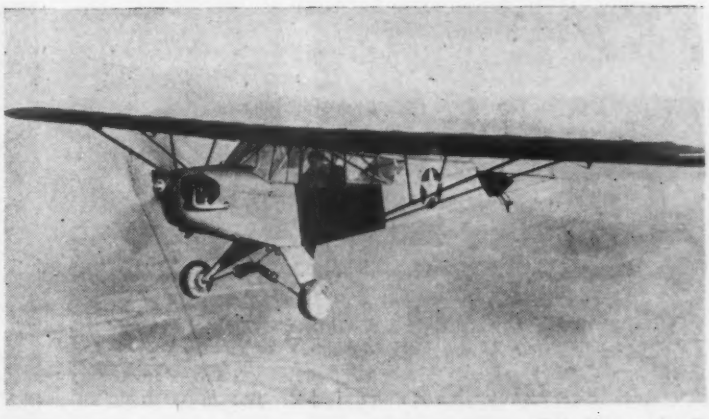




North American AT-6 Texan

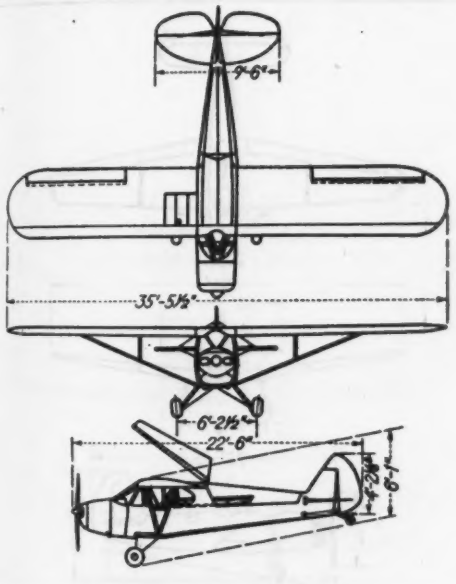
American Air Forces' most widely used advanced trainer, and standard for such work with several other nations' air arms. **High speed, 205 mph. at 5,000 ft.,** cruising speed, 190 mph., range 750 mi., gross weight, 5,245 lb., weight empty, 4,103 lb. Power, 600-hp. Pratt & Whitney. **Has service ceiling of 21,500 ft.**

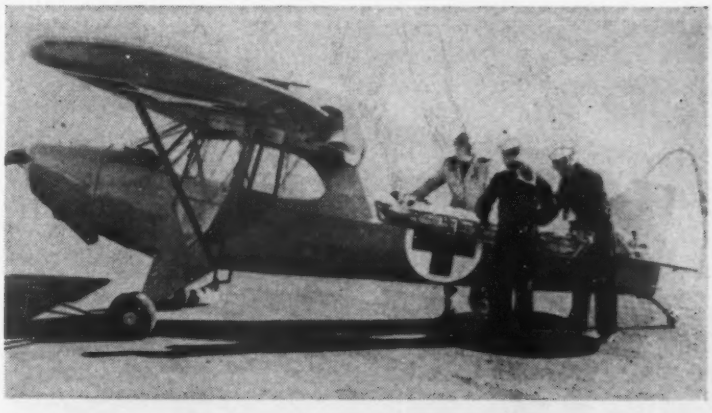




Piper L-4H

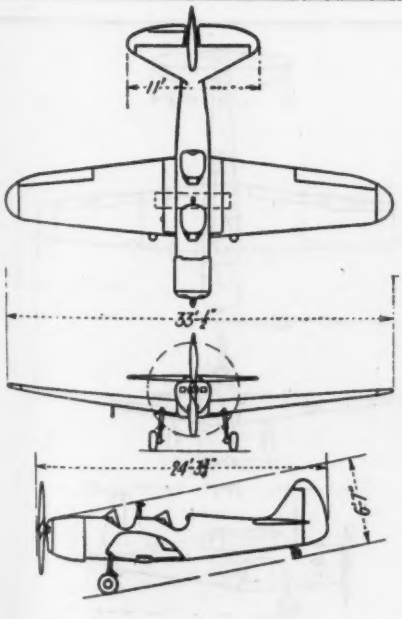
Famed in news dispatches as Cub liaison craft serving in all theatres. These little jobs have even taken to carrying rockets for additional ground cooperation work. High speed 87 mph., cruising speed, 75 mph., landing speed, 38 mph., climb, 450 fpm., gross weight, 1,220 lb., power, 65-hp. Continental.

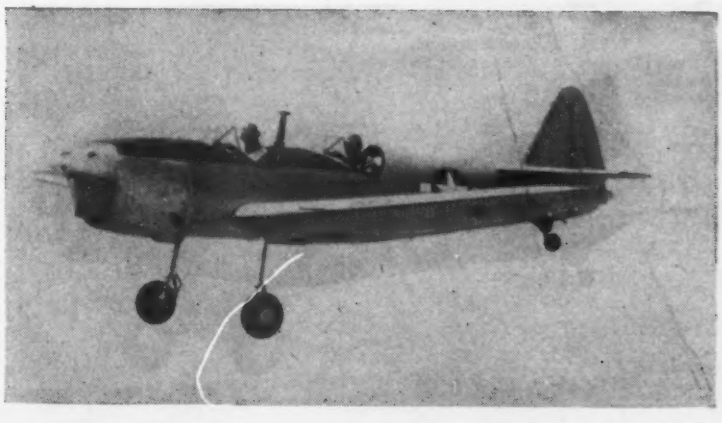




Piper AE-1

An ambulance plane developed from the basic Cub design but with more powerful engine—a 100-hp. Lycoming—giving high speed of 110 mph. at 3,000 ft., and cruising speed of 95 at same altitude. Landing speed, 45 mph. Gross and empty weights are 1,427 and 906 lb., respectively; ranges 238 and 220 mi.





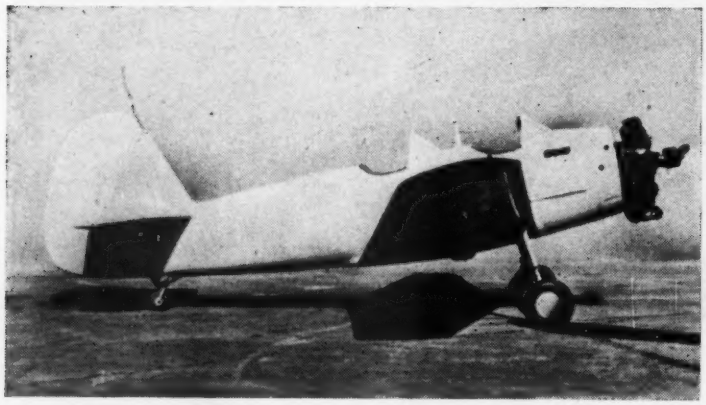
Ryan PT-25

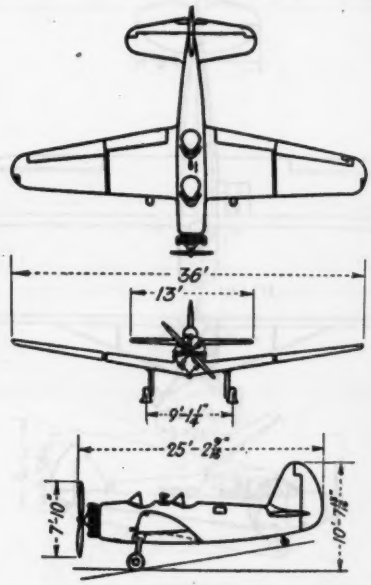
An all-wood primary trainer developed to avoid use of strategic materials during severe metal shortage. High speed 149 mph., cruising speed, 134 mph., range, 378 mi., gross weight, 1,800 lb., weight empty, 1,235 lb., service ceiling, 20,300 ft. One 185-hp. Lycoming engine gives initial rate of climb listed as 1,590 fpm.

AMERICAN LIAISON-TRAINERS

Taylorcraft L-2

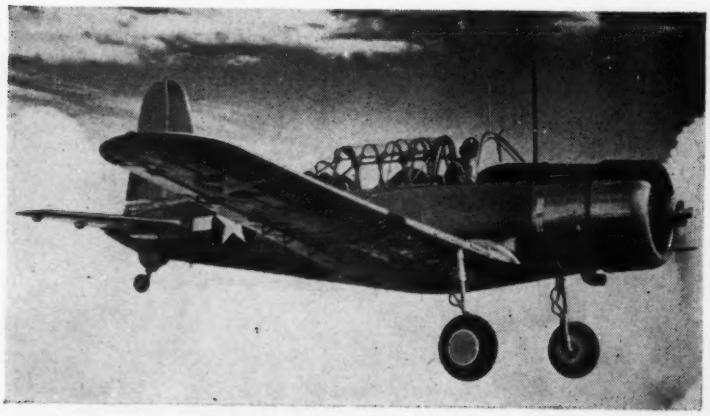
Produced with three power plants: 65-hp. Continental as L-2H; similarly rated Lycoming as L-2J; and by Franklin as L-2K. Specifications remain constant, including high speed, 105 mph., cruising 95 mph., landing speed, 35 mph., service ceiling, 15,000 ft., range, 375 mi., gross wt., 1,200 lb.

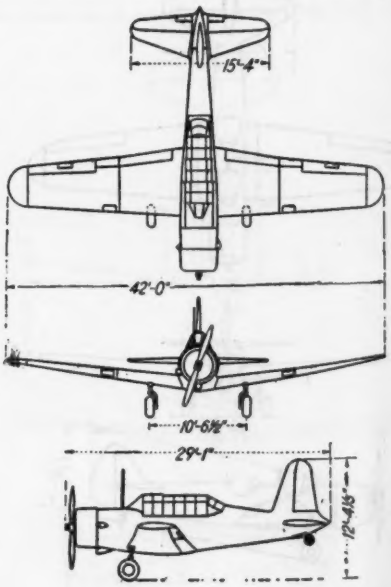




Timm N2T-1

All-wood primary trainer developed for Navy. High speed 135 mph., cruising speed, 115 mph., normal range, 340 mi., fuel capacity, 42 gal., service ceiling, 15,000 ft., initial climb, 1,000 fpm., gross weight, 2,725 lb. Powered by one 220-hp. Continental.

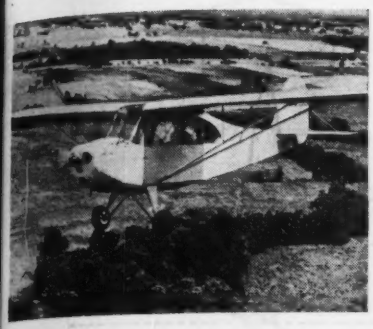




Vultee BT-13 Valiant

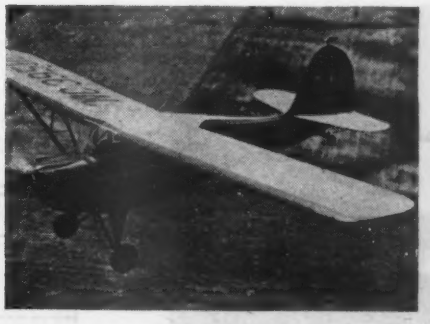
One of AAF's most widely used basic trainers. All-metal craft having high speed of 166 mph., and cruising speed of 140. Fuel capacity, 120 gal., mormal range, 516 mi., service ceiling, 17,900 ft. Gross weight, 4,360 lb., weight empty, 3,345 lb. Power, 450-hp. Pratt & Whitney Wasp Junior giving 666-fpm. climb at sea level.

AMERICAN PERSONAL PLANES



Aeronca Champion

Two-place tandem seater designed for training and general utility flying. High speed, 100 mph., cruising speed, 90 mph., landing speed, 38 mph., climb, 500 fpm., fuel capacity, 15 gal., cruising range, 270 mi. Gross wt., 1,220 lb., useful load, 510 lb., wt. empty, 710 lb. Will be powered by 65-hp. engine; also available with floats for water-based operations.

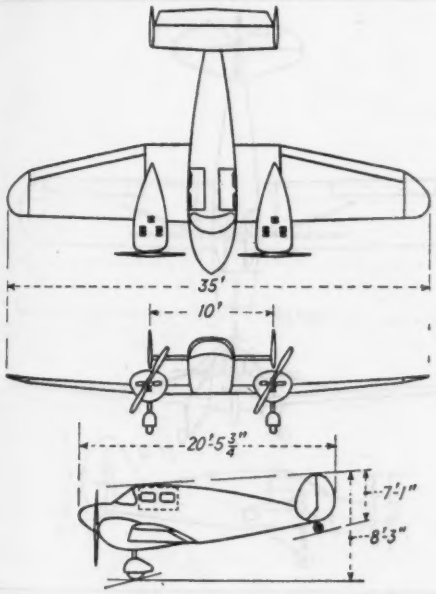


Aeronca Chief

De luxe two-place side by side high wing personal plane designed for production as soon as conditions permit. High speed, 100 mph., cruising speed, 90 mph., landing speed, 38 mph., rate of climb, 500 fpm., fuel capacity, 16 gal., 24 with auxiliary tank. Cruising range with auxiliary tank, 420 mi. Will have 65-hp. engine. Seaplane version to be available.

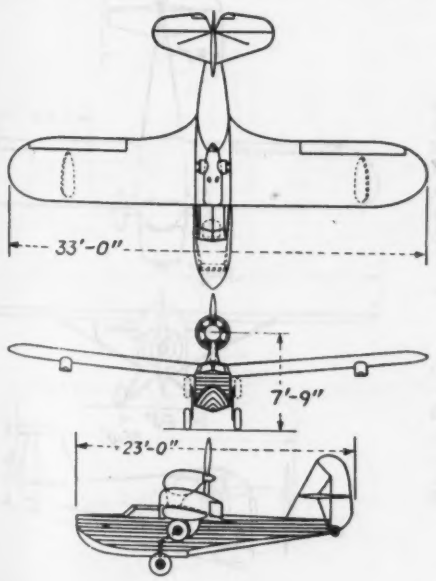
Aeronca Arrow

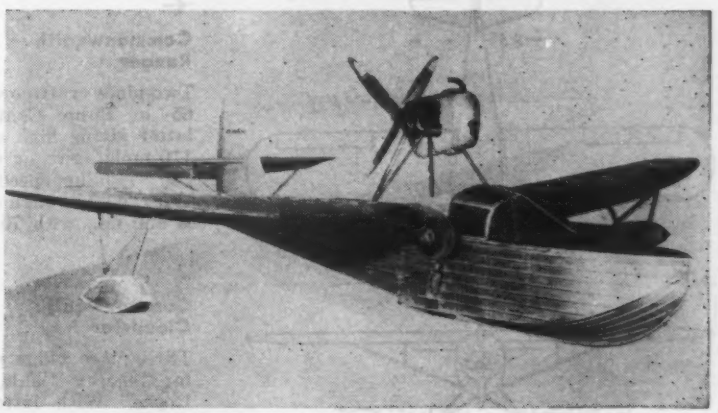
Two-place all metal design with retractable landing gear. High speed, 135 mph., cruising speed, 125 mph., landing speed with flaps, 48 mph., without flaps, 54 mph., rate of climb, 550 fpm. Fuel capacity, 25 gal., cruising range, 500 mi. Wt. empty, 850 lb., useful load, including 90 lb. of baggage, 600 lb., gross wt. 1,450 lb. Has 90-hp. aircooled engine.



Andover Kent Langley

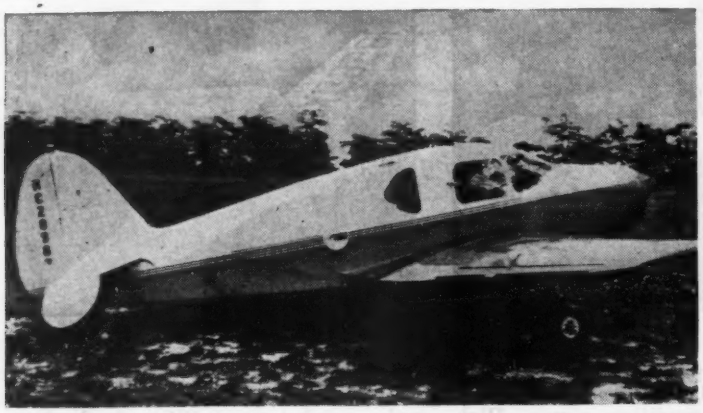
All-wood four-place craft developed for personal plane market. High speed, 138 mph., cruising speed, 117 mph., landing speed, 60 mph., normal range, 350 mi., fuel capacity, 35 gal. Gross weight, 2,650 lb., weight empty, 1,738 lb., initial climb, 695 fpm., service ceiling, 13,300 ft. Power, two 90-hp. Franklins.

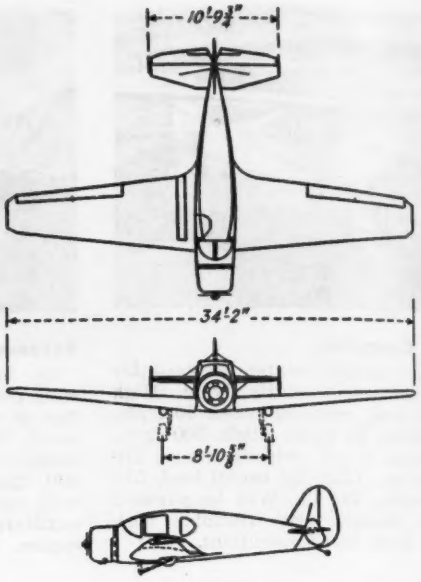




Applegate Amphibian

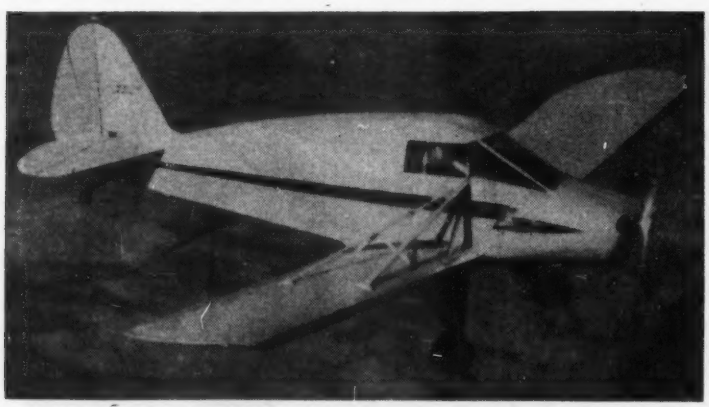
One of smallest personal amphibians, developed by Ray Applegate for postwar markets. Gross wt., 1,500 lb., wt. empty, 1,065 lb., baggage allowance, 50 lb., high speed 100 mph., cruising speed 92 mph., landing speed, 37 mph., range 600 mi. Power, 90-hp. Franklin four turning four blade, fixed pitch wood propeller.

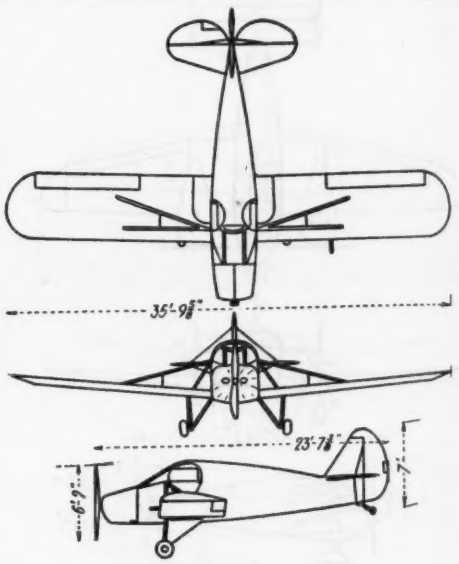




Bellanca Cruisair 14-F

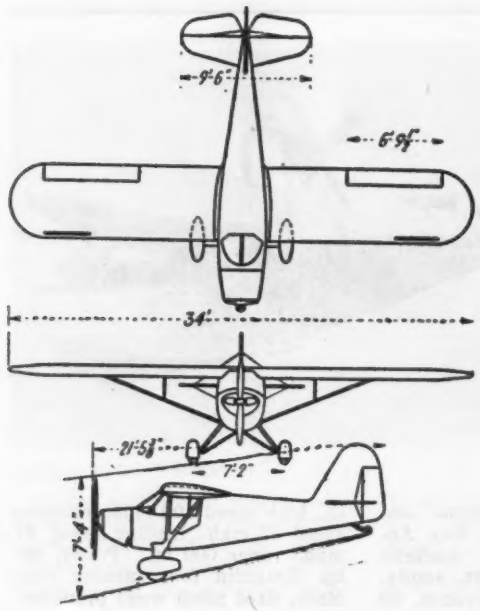
Three-place combination wood and metal craft in the $3,500 class. High speed, 150 mph., cruising speed, 130 at sea level; service ceiling, 12,000 ft., fuel capacity, 20 gals., normal range, 400 mi., gross weight, 1,900 lb., weight empty, 1,140 lb. Power: one 120-hp. Franklin. Features a retractable landing gear.





Callair A

Two-place craft of conventional design bearing ATC No. 758. High speed, 112 mph. at sea level; cruising speed 101 mph., service ceiling 15,500 ft., fuel capacity, 25 gal., normal range, 342 mi., gross weight, 1,550 lb., weight empty, 1,050. Power, one 100-hp. Lycoming. Initial rate of climb, 710 fpm., landing speed 45 mph.



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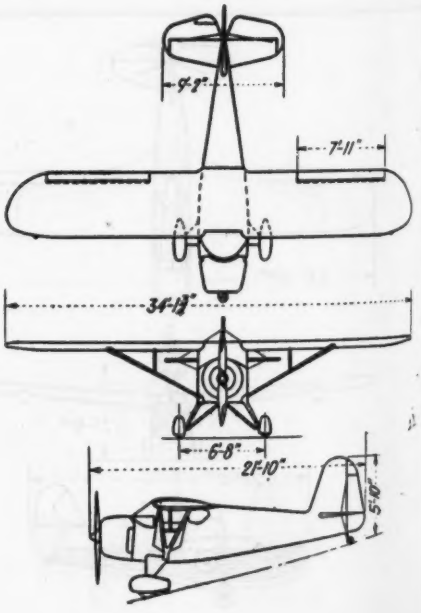
Commonwealth Ranger

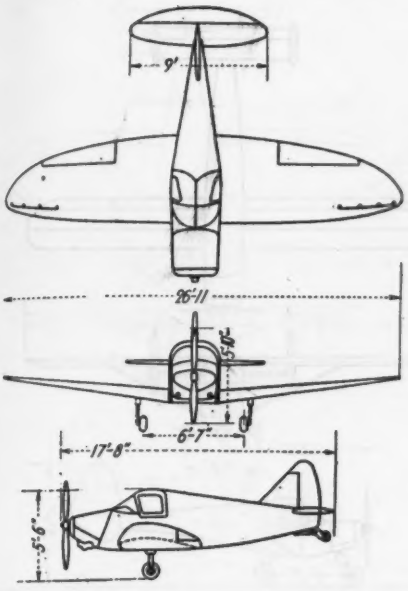
Two-place craft powered by 65- or 75-hp. Continental, latter giving high speed of 110 mph., cruising speed of 100; landing speed of 40. With 65-hp. engine range is 450 mi., with 75 is 400.

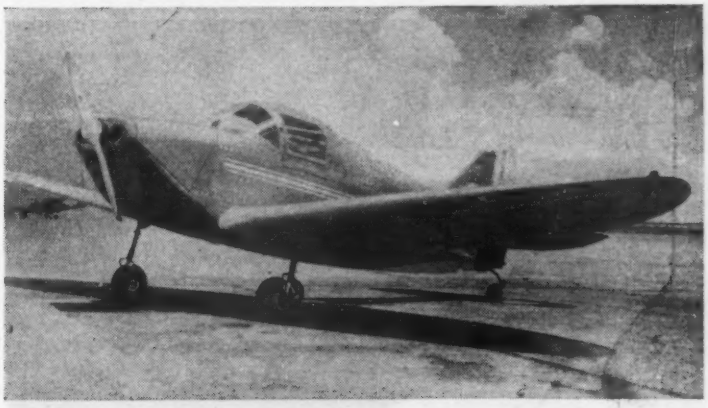
→

Commonwealth Cloudster

Three-place plane designed for 90- or 120-hp. Ken-Royce. With latter, high speed is 145 mph., cruising, 125; landing 50 mph., range 600 mi., gross wt., 1,800 lb., wt. empty, 1,120 lb.

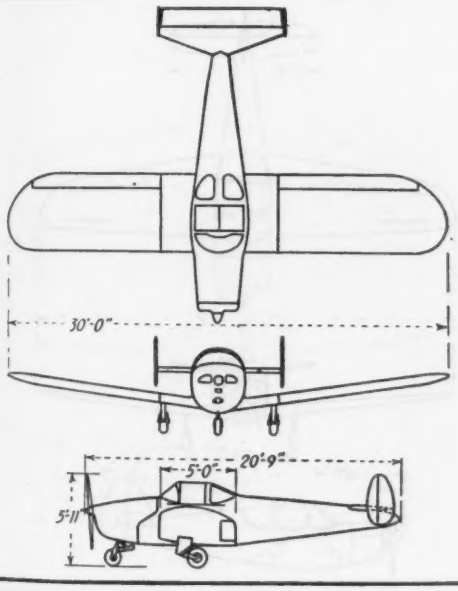


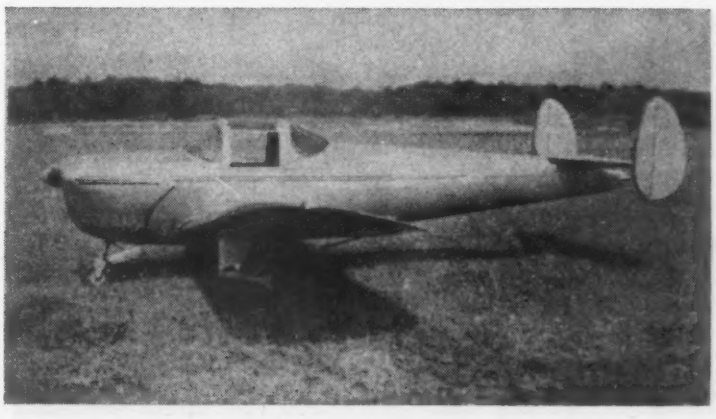




Culver Cadet

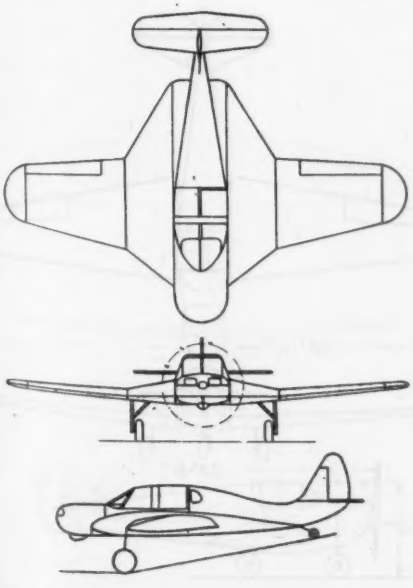
High performance two-place craft, one of first personal planes to have retractable landing gear. High speed, 140 mph., cruising speed, 120 mph., service ceiling, 17,500 ft., fuel capacity, 20 gal., range 480 mi., gross weight, 1,305 lb., wt. empty, 860 lb. Powered by 80-hp. Franklin engine. Initial rate of climb, 800 fpm.

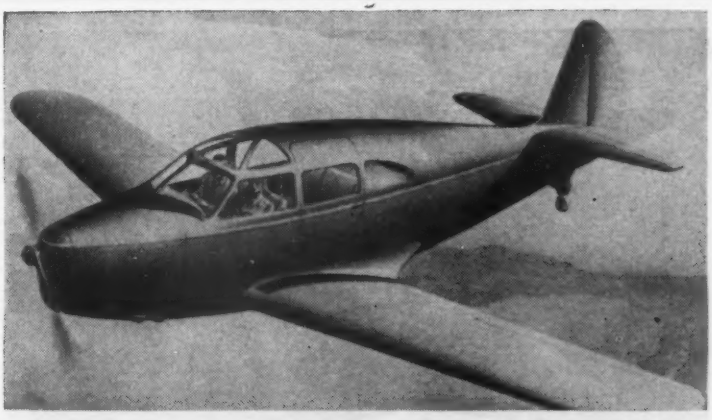




Engineering & Research Corp. Ercoupe

One of nation's two spin-proof, two-control airplanes, Ercoupe is an all-metal two-place craft. High speed, 117 mph., cruising speed 105 mph., service ceiling; 3,000 ft., fuel capacity, 23 gal., normal range, 525 mi., gross weight, 1,260 lb., weight empty, 725 lb. Power, 65-hp. Continental. Landing speed, 48 mph., climb, 700 fpm.





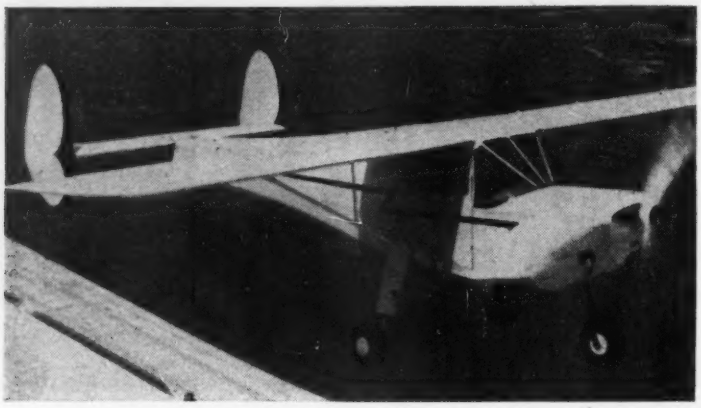
Eshelman FW-5

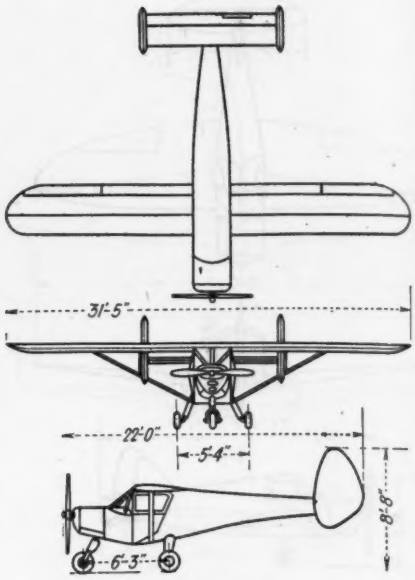
Left, for postwar private owner has Lycoming 235-hp. engine, top speed 180 mph., cruising 165, range 700 mi. Construction steel tube with fabric covering.

Fairchild M-84

Artist's drawing of four-five place "family" plane, prototype of which is now being built. Production to begin when materials are available.

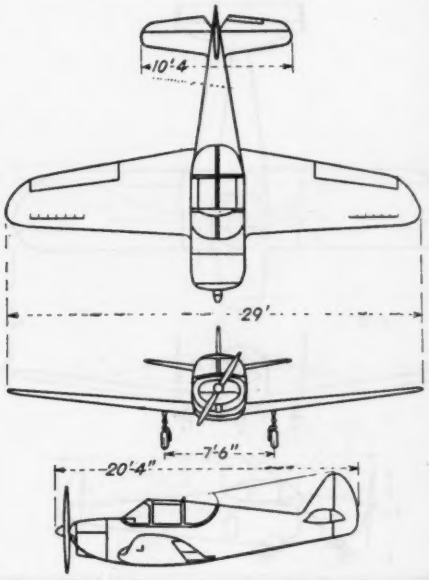
AMERICAN PERSONAL





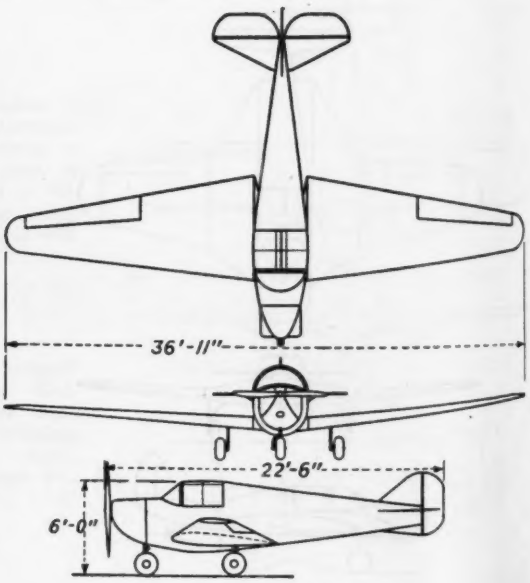
General G1-80 Skyfarer

Second of America's two-control, spin-proof planes. Developed by General Aircraft of New Jersey, to be produced by Le Mars Aircraft as Skycoupe; General will produce other models postwar. High speed 100 mph., cruising, 92; range, 400 mi., gross weight, 1,350 lb., wt. empty, 890 lb., power 75-hp. Lycoming.



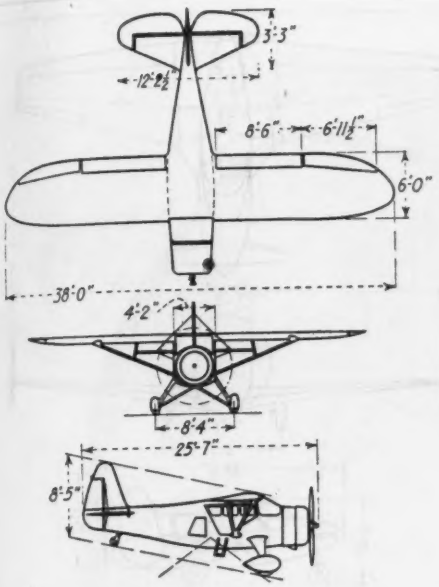
Globe GC-1A Swift

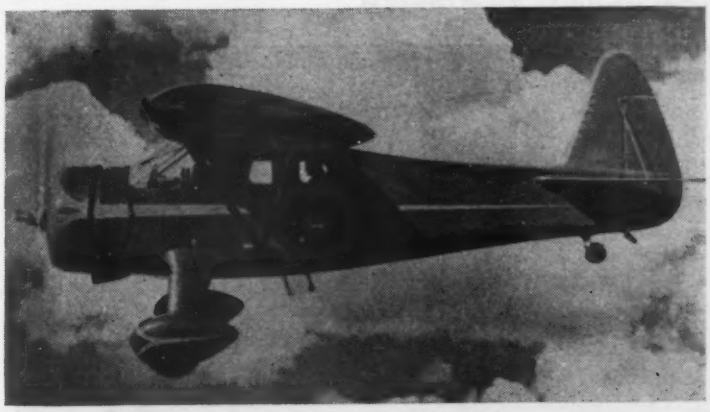
Revised version of earlier Globe Swift, designed for postwar production. Retractable landing gear; high speed, 135 mph., cruising speed, 125 mph., service ceiling, 14,200 ft., fuel capacity 26 gal., normal range, 600 mi., gross wt., 1,569 lb. 85-hp. Continental. New version has all-metal fuselage, plywood wings.



Gregg Rocket A-75

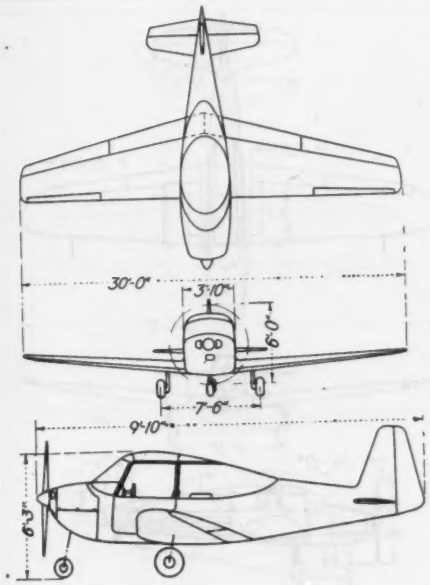
Two-place, all-metal semi-monocoque construction craft, with fixed tricycle landing gear. High speed, 116 mph., cruising speed, 110 mph., service ceiling, 15,000 ft., fuel capacity, 18 gal., normal range, 440 mi., gross wt., 1,302 lb., wt. empty, 734 lb. Power, 75-hp. Continental. Landing speed, 42 mph., climb, 850 fpm.



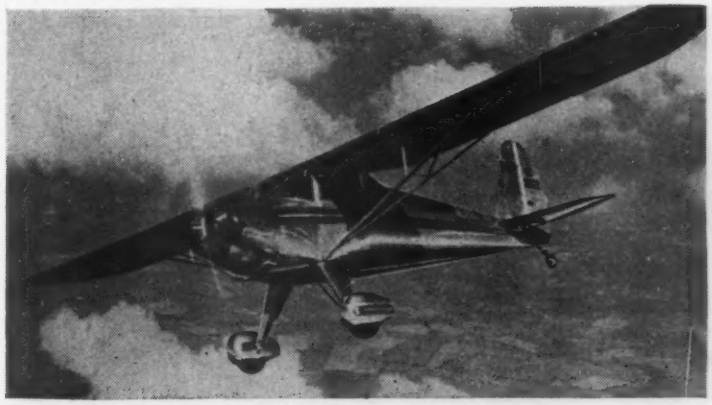


Howard DGA-15P

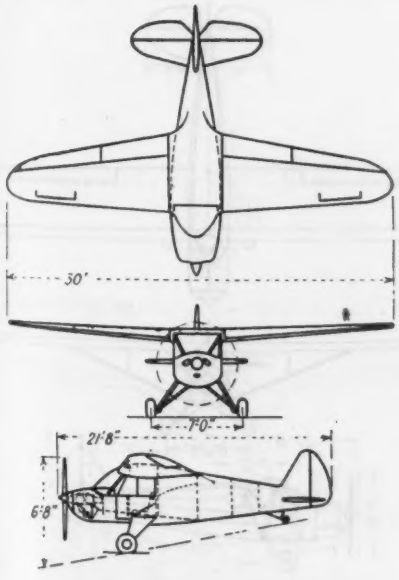
High performance personal plane also used by Army and Navy for fast personnel carrier. Cruising speed, 192 mph., initial rate of climb, 1,560 fpm., service ceiling, 21,500 ft., fuel capacity, 120 gal., normal range 920 mi. gross wt., 4,500 lb., wt. empty, 3,028. Powered by 400-hp. Pratt & Whitney Wasp Junior.



Naugle N-12 (left), proposed three-place personal craft to have 162-mph. high speed; 140 mph. cruising speed; range 450 mi. Power, one 90-hp. Lycoming.

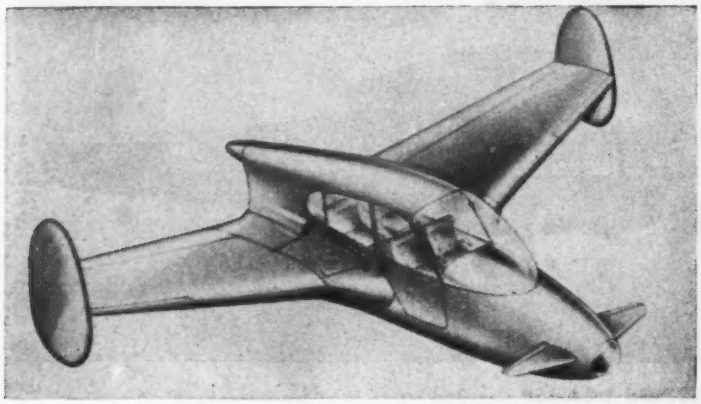


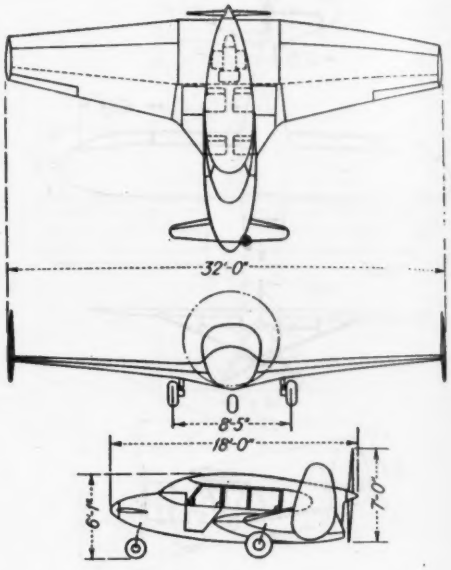
Luscombe Silvaire (above) on which production is to be resumed. High speed 115 mph., cruising speed, 109; range, 450 mi. Power, Continental 75.



Naugle Mercury

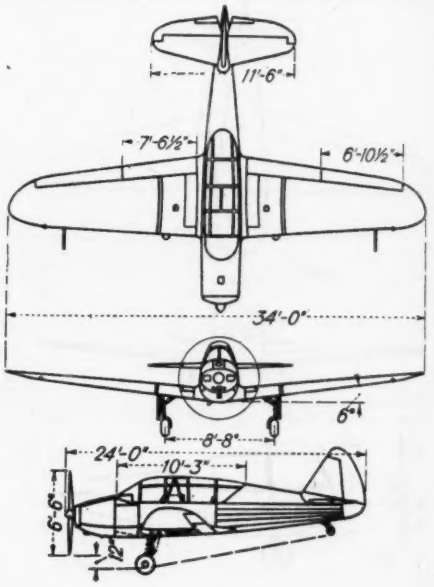
All-metal two-place light-plane with 145-mph. high speed, 130-mph. cruising speed and 45-mph. landing speed. Fuel capacity, 15 gal., range 480 mi. Gross wt., 1,150 lb., wt. empty, 610 lb. Climb, 1,200 fpm., service ceiling, 20,000 ft. Power, 75-hp. Lycoming. Fuselage is stressed skin monocoque construction.





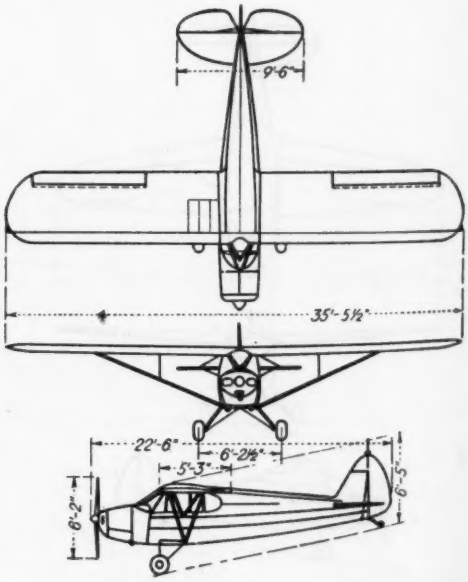
Naugle N-6

Proposed four-place canard type designed for postwar production. Built around stainless steel "keel" extending from nose aft to form engine mount and propeller shaft mount. To have 125-hp. Lycoming six engine giving high speed of 185 mph., cruising speed of 170 with range of 520 mi.



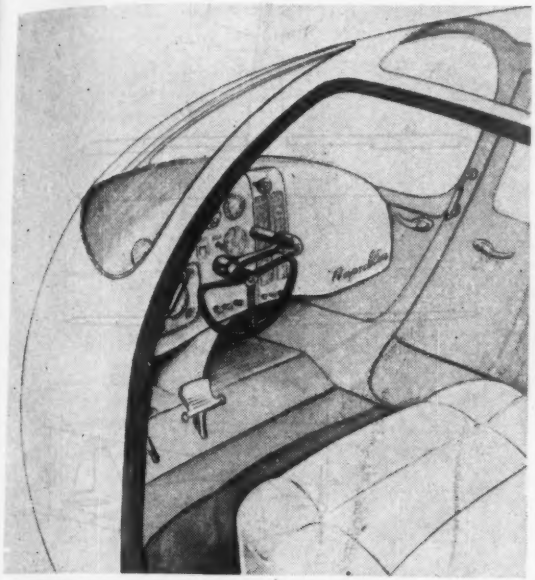
Piper PT-1

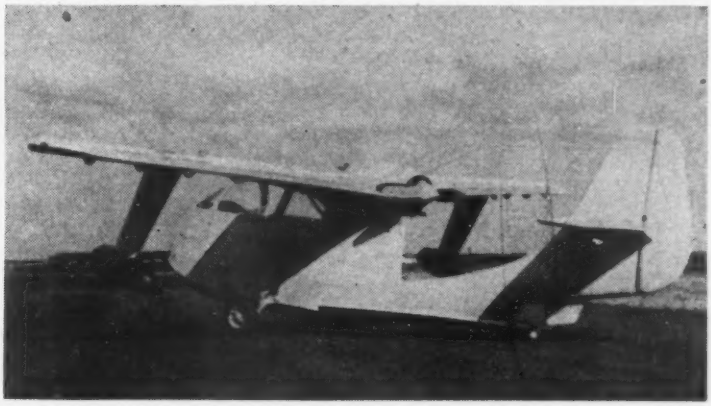
Prototype has been built and test flown; type is expected to be available postwar for training and personal use. High speed, over 150 mph., cruising, 135 plus; landing speed, under 50 mph., climb over 750 fpm., fuel capacity, 40 gal., normal range, 700 mi., gross wt., 2,000 lb., wt. empty, 1,325 lb. Power, 130-hp. Franklin.



Piper J5-C Cub Coupe

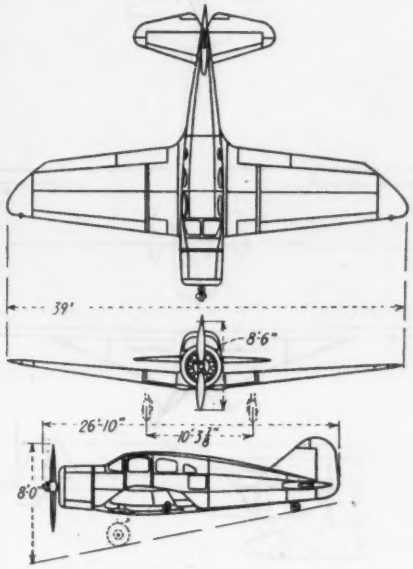
One of nation's most popular prewar two-place personal planes. Powered by 100-hp. Lycoming, has top speed of 110 mph. at 3,000 ft., cruising speed of 95 mph. at same altitude; climb of 600 fpm., and service ceiling of 15,000 ft. With 20-gal. fuel capacity, range is 238 mi. Postwar version to be produced as soon as possible.





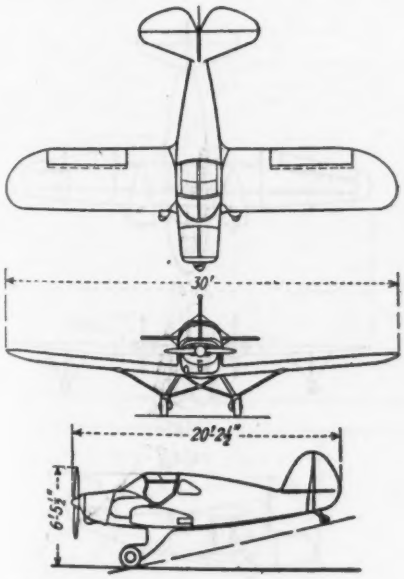
Republic Thunderbolt Amphibian

Three-to-four place postwar craft designed to sell for less than $4,000. To be powered by engine in 175-hp. class, giving high speed of 120 mph., cruising of 105. Gross wt. to be about 2,600 lb., range of 525 mi. Landing speed, 50 mph. Production model to be all-metal with output scheduled upon availability of manpower.



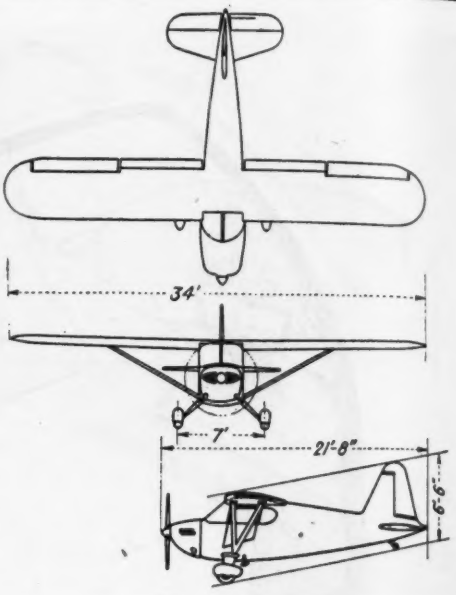
Spartan Executive

High performance five-place craft used by military for personnel transport. High speed, 212 mph., cruising, 208 at 9,600 ft., fuel capacity, 112 gal., range, 1,000 mi. Power, 400-hp. P. & W. Improvered version of this model is being readied for postwar production. Spartan plans to build a twin engine personal plane.



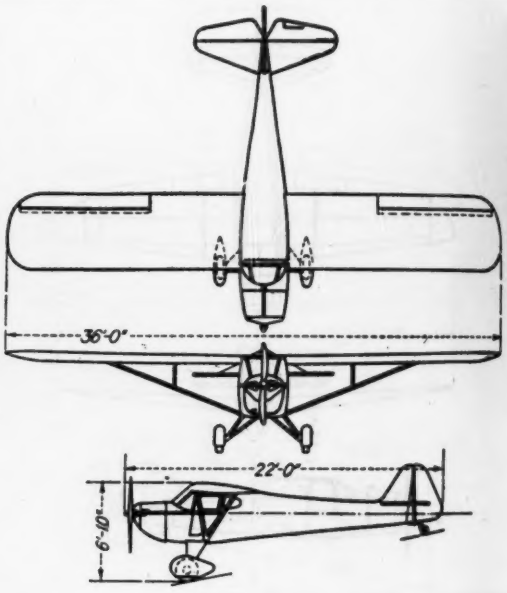
Stearman Ariel

Designed for 75-hp. Continental or 80-hp. Franklin. With latter installation has 127-mph. high speed; 112 mph. cruising speed; 43-mph. landing speed; 1,050 fpm. initial climb and service ceiling of 17,000 ft. Fuel capacity, 20 gal, range 420 mi. Gross wt., 1,200 lb., wt. empty, 680 lb. Another designed around Lycoming.



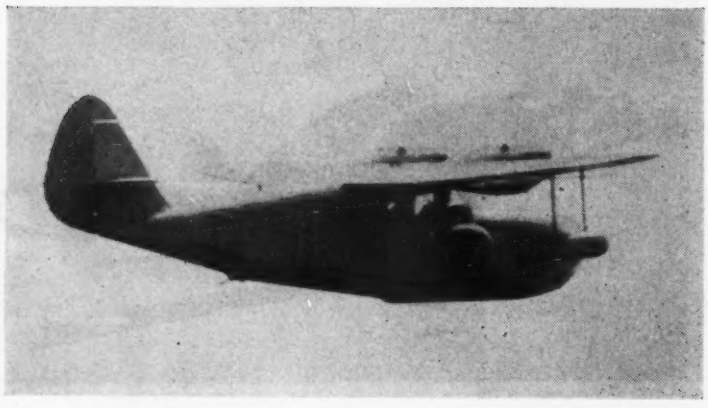
Stinson Voyager 125

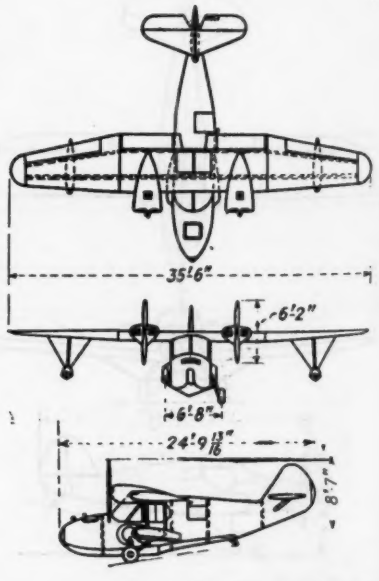
New and larger version of popular 105, three-view of which is shown at right. This model has high speed of 123 mph., cruising of 112 and landing speed of 51 mph. Gross wt., 1,875 lb., wt. empty, 1,118 lb., range, 470 mi. Power, 125-hp. Lycoming six.



Taylorcraft Model B-15

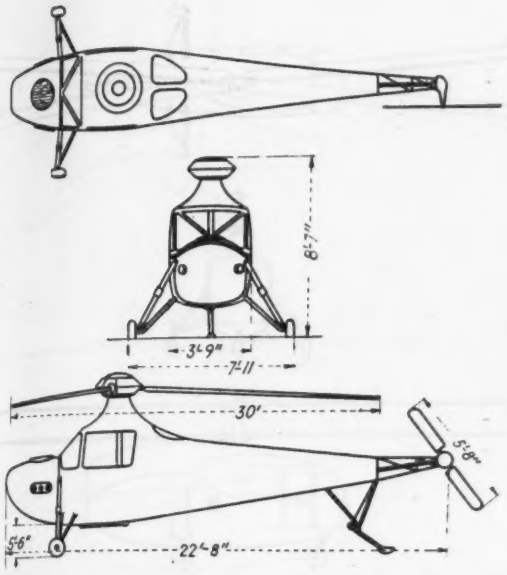
Four-place "family" craft designed for postwar production to sell in the $4,000-class. With 125-hp. engine, high speed is 125 mph., cruising speed 112; landing speed 40. Fuel capacity, 38 gals., gross wt., 2,250 lb., wt. empty, 1,275. Model has doors for both front and rear seat passengers. Three-view shows B-12.





Trimmer Amphibian

Designed for postwar market to sell under $4,000. All-wood construction 3-place craft having high speed of 135 mph., cruising speed of 115 and service ceiling of 12,500 ft. Gross wt., 2,200 lb., wt. empty, 1,520 lb., range, 250-600 mi. Power, two 85-hp. Continentals. Landing speed is 48 mph., rate of climb, 750 fpm.

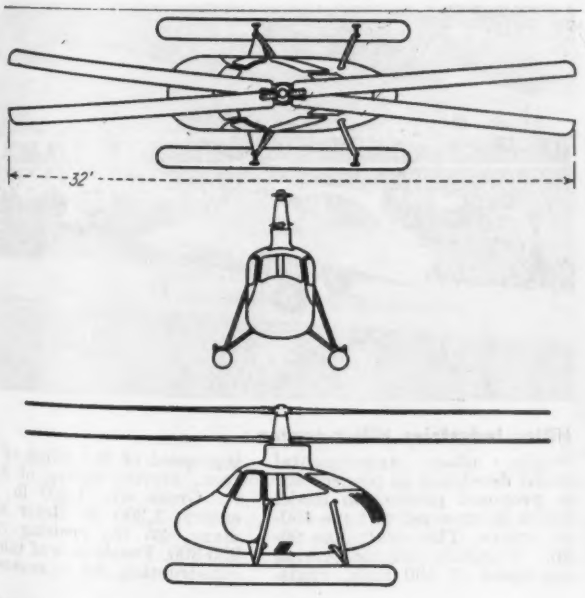


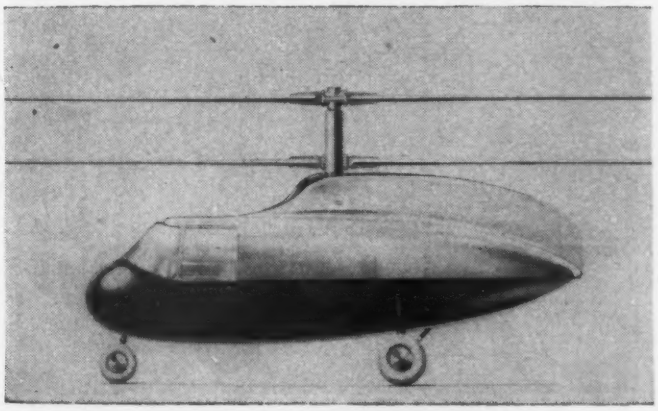
Aeronauticql Products Model 3A

Two-place craft using standard engine, mounted in front to save production costs and facilitate maintenance. High speed, 100 mph., cruising speed, 80 mph., climb, 1,100 fpm., service ceiling, 11,000 ft. Main rotor blade cruising rpm., 250. Powered by 6 cyclinder 150-hp. Franklin.

Bell

Flying laboratory incorporating theories developed by Arthur Young, who heads Bell helicopter development projects, during ten years experimental and development work. One outstanding difference from other rotary wing craft is use of stabilizing bar set at right angles to main two-blade rotor, which is of solid wood construction incorporating steel inset in leading edge. Main rotor blade has 33-ft. diameter; anti-torque rotor has 5-ft. diameter. Fuselage is of tubular section with metal and fabric covering with side-by-side seating for two. This model is powered by a 160-hp. Franklin six, set vertically just behind pilot's compartment. Front wheels of tricycle landing gear are full castering.





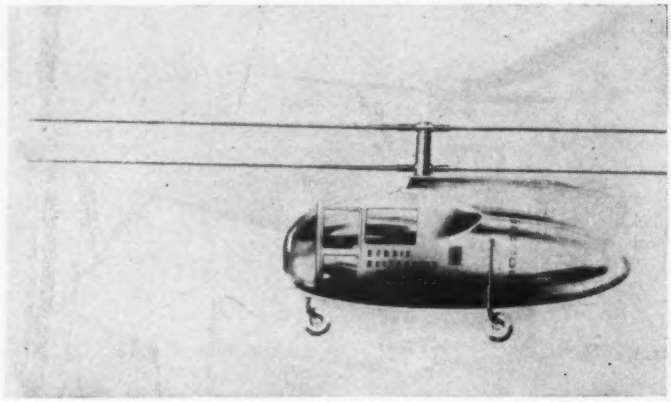
Bendix Model G (Left)

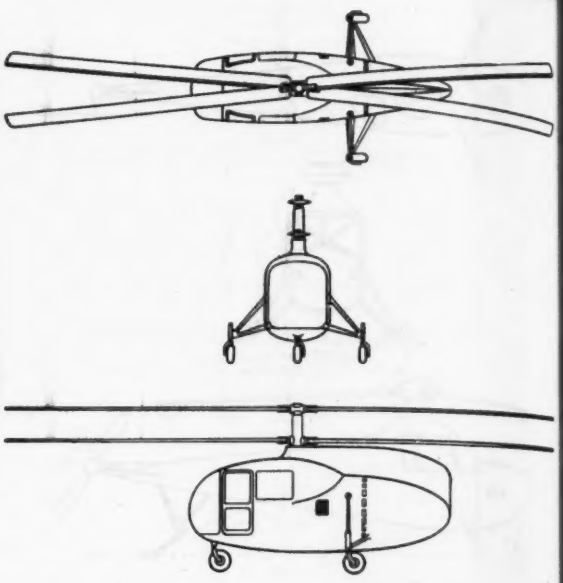
Under development, this craft will have 120-mph. high speed, 100-mph. cruising speed, range of 300 mi. To be powered by 165-hp. Warner. Gross wt., 2,000 lb.

Bendix Model H (Above)

To be powered by 500-hp. engine, this craft is now under development as a freight carrier, but is being designed for easy conversion for passenger use.

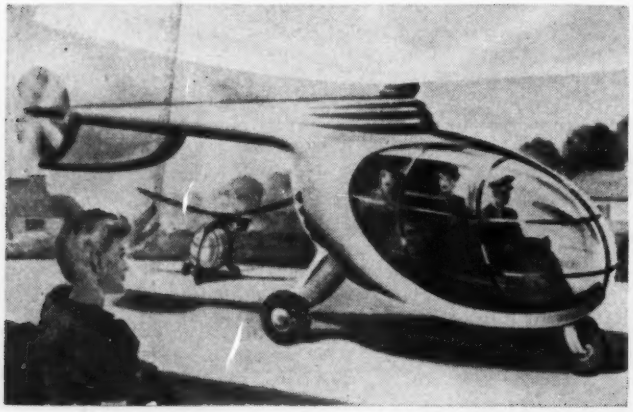
AMERICAN HELICOPTERS





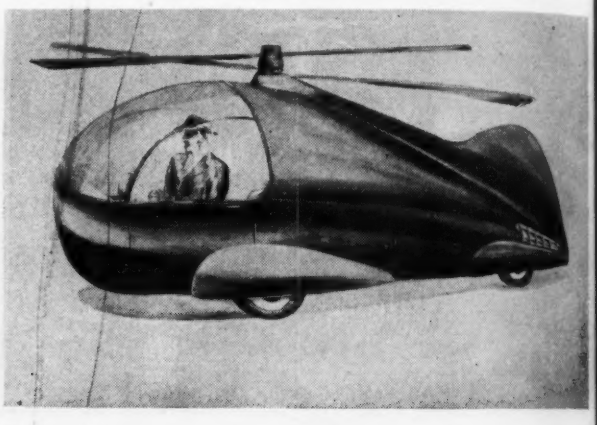
Bendix Model I

Four-place co-axial rotored 'copter now under development. Continental W-670 engine of 300 hp. contemplated for production model, which will have high speed of 120 mph., cruising speed of 105 mph., fuel capacity of 75 gal. giving range of 420 mi. Gross wt., 3,036 lb., wt. empty, 1,925 lb.



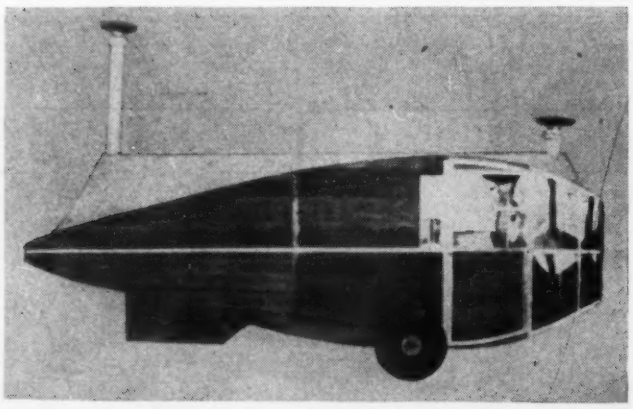
Stout Helicab

Under design at Stout Div., Consolidated Vultee Aircraft Corp. According to designer, craft will be powered by 125-hp. engine, will carry from two to five passengers, with gross wt., including baggage, at 1,700 lb. Main rotor diam. 33 ft., anti-torque rotor diam., 6 ft. Fuselage to be metal construction, with skin of undisclosed plastic.



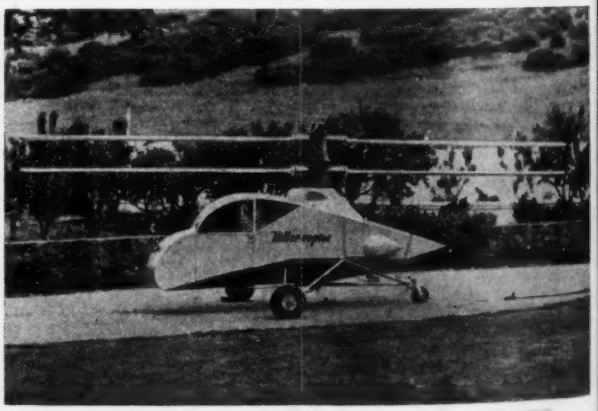
WCK'copter

West Coast development now under construction under company designation Flymobile. Powered by 90-hp. Franklin, craft is designed to have 95-mph. high speed; 80 mph. cruising; 5,000-ft. ceiling and range of 40 mile on 5-gal. fuel capacity. Co-axial main rotor blades of 25-ft. diameter cruising at 325 rpm., fabric-covered tubular fuselage.



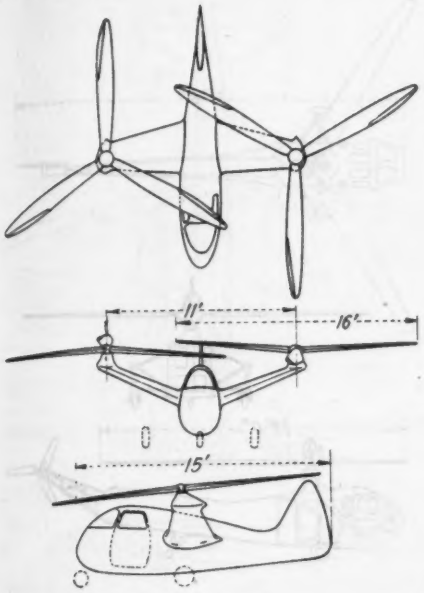
Hartwig-Little 'Copter

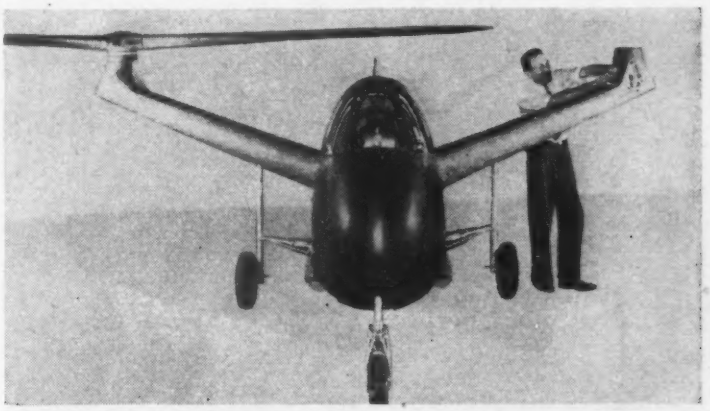
Developed by Hartwig Aircraft, prototype reported to have lifted 1,700 lb. three ft. above ground during first flight tests. Co-axial rotors mounted on shafts at either end of fuselage. Powered by 90-hp. Franklin, designed for high speed of 125 mph., cruising speed of 100; climb of 600 fpm. and service ceiling of 7,000 ft. Rotor blade diam., 23 ft., plywood-covered fuselage. Gross wt., 1,600 lb.



Hiller Industries Hiller-copter

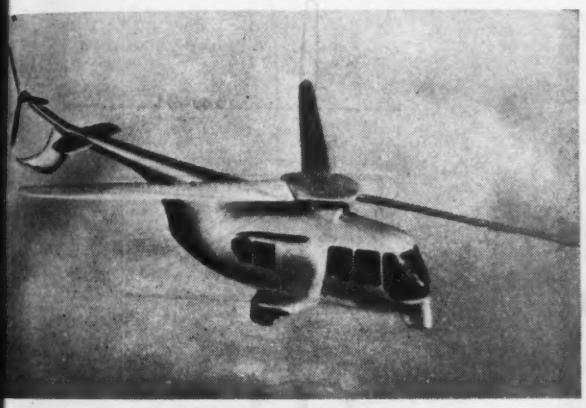
Single - place experimental model developed as predecessor to proposed production model which is expected to have 450-mi. range. This craft has 90-hp. Franklin engine giving top speed of 100 mph., cruising speed of 85; climb of 600 fpm., service ceiling of 8,000 ft. Gross wt., 1,400 lb., wt. empty, 1,200 lb. Rotor blade diam., 25 ft., cruising rpm., 250-300. Fuselage is of tubular construction, fabric covered.





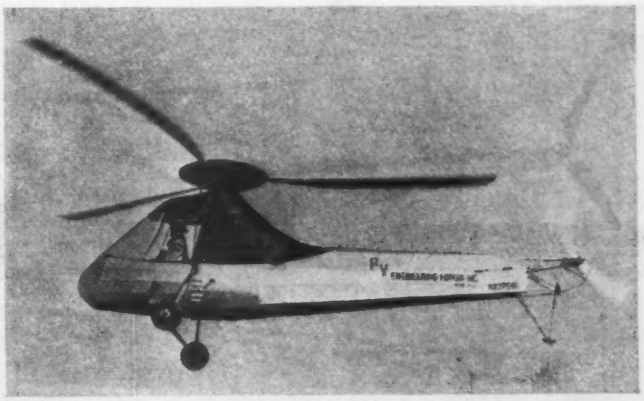
Landgraf H-2

Single-place craft, it is first retractable landing gear helicopter. Rotor blades of wood, plywood-covered; fuselage wood monocoque construction. Twin co-axial three blade rotors have span of 16 ft., 5-ft. overlap and cruise at 440 rpm. Gross wt., 850 lb., wt. empty, 636 lb. Powered by 85-hp. Pobjoy. (Also see Aviation, Oct., 1944, p. 186 and this issue, page 193.)



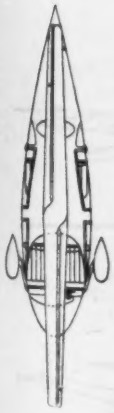
ennsylvania Aircraft Syndicate Ltd., Cyrocopter

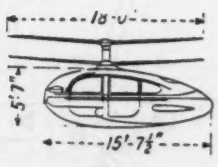
ow under development, craft designed to have two 1,000-. Wright engines, giving high eed of 135 mph., cruising eed of 119 mph., climb of 0 fpm. and service ceiling of 18,000 ft. in transport service. To carry 18 passengers, gross wt. will be 16,000 lb., wt. empty 10,000. Three blade cyclic - feathering, semi - rigid blades to have 80-ft. diam.



P-V Engineering Forum PV-2

Single-place laboratory model built as predecessor to larger model now under design with 2,000-lb. payload. Powered by 90-hp. Franklin, PV-2 has high speed of 90-100 mph.. cruising speed of 85; climb of 1,100 fpm., service ceiling of 10,000 ft. Three-blade main rotor has 25-ft. diam., cruises at 370 rpm., anti-torque rotor has 5-ft. diam., cruises at 1,670 rpm.



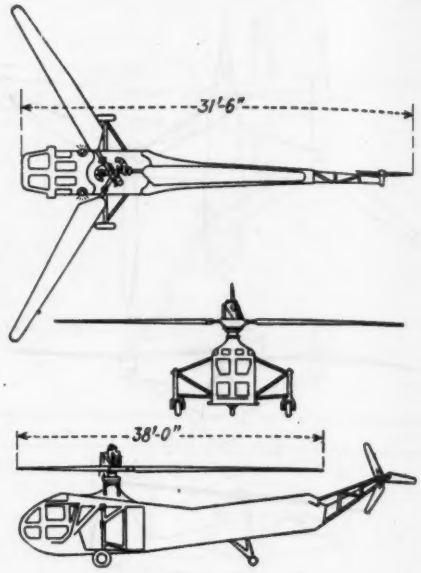


Twin Coach Co. Hover-Twin

Two-place contra-rotating co-axial craft having rotor blade diam. of 30 ft. Powered by two 75-hp. Continentals—design calls for maintained flight on either one—craft is designed for high speed of 100 mph., cruising speed of 75 mph., and climb of 500 fpm. Rotor blade spar of plywood, fabric-covered; fuselage welded tubing, fabric-covered.

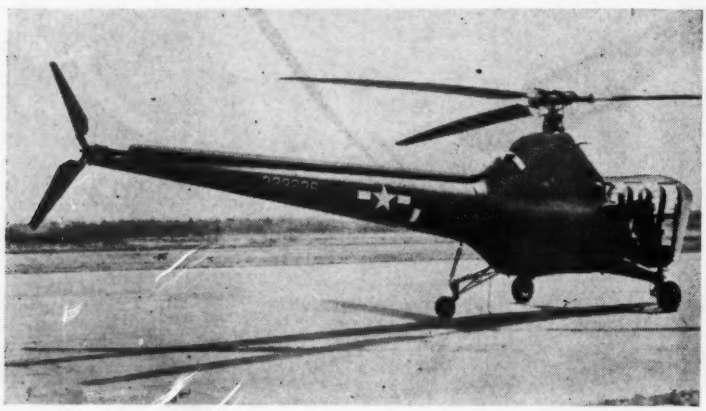
Platt-Le Page R-1A

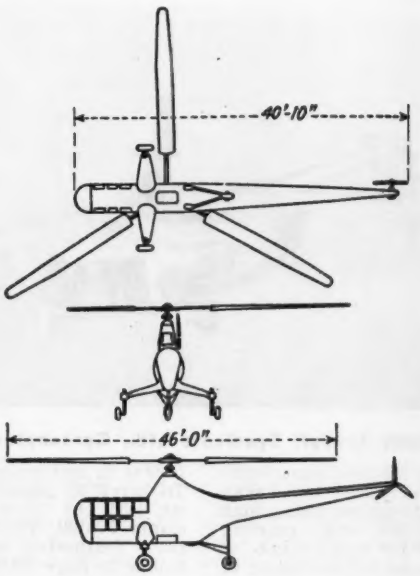
Two-place tandem-seating 450-hp. craft recently delivered to AAF for testing. Contra-rotating rotors mounted on cantilever booms each have 30½-ft. diam. Company has also done some design work on 12-14 passenger twin-rotor craft of some 17,000-lb. gross weight designed for postwar transport work with operating costs said to be comparable to conventional planes.



Sikorsky R-4

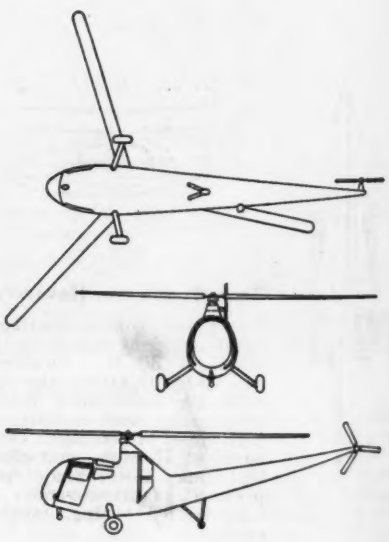
First helicopter to go into quantity production and first to be accepted for military service. Two-place craft powered by 180-hp. Warner Superscarab. Diam. of 3-blade main rotor, 38 ft., diam. of 3-blade anti-torque rotor, 7 ft. 8 in. Gross wt., 2,530 lb. wt. empty, 2,011. Used by Coast Guard for rescue work.





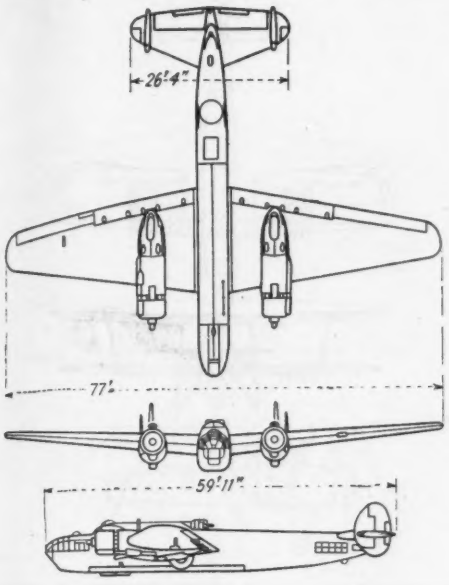
Sikorsky R-5

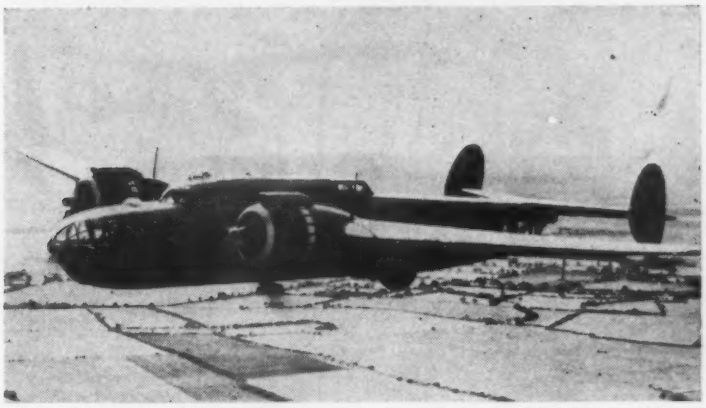
Two-place tandem seater. Semi-monocoque tail boom replaces truss tubular structure of R-4. Largest and most powerful of Sikorsky type built. Powered by 450-hp. Pratt & Whitney Wasp Jr., R-4., has 3-blade rotor of 46 ft. diam., length of 40 ft. 10 in., gross wt. of 4,800 lb., wt. empty, 3,275 lb.



Sikorsky R-6

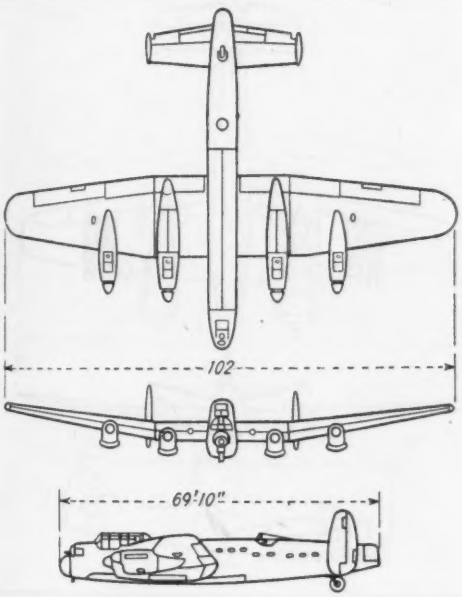
Two-place tandem dual control craft being built by Nash-Kelvinator under license. Powered by 245-hp. Franklin, R-6 has top speed of 100 mph., cruising range of about 5 hr., and rate-of-climb of better than 550 fpm. Main 3-blade rotor diameter is 38 ft., 3-blade anti-torque rotor diameter is just over 7 ft.

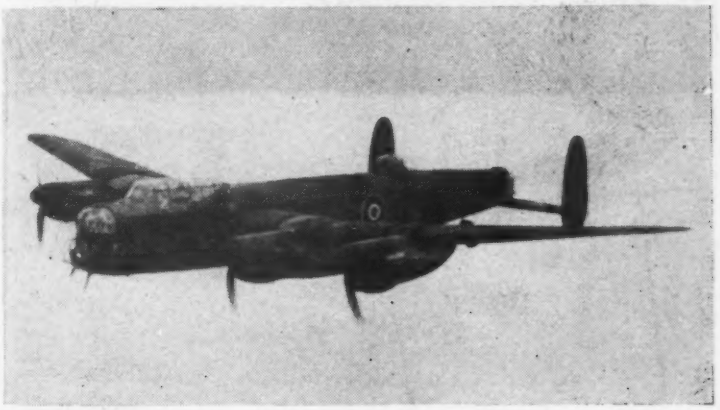




Armstrong-Whitworth Albermarle II

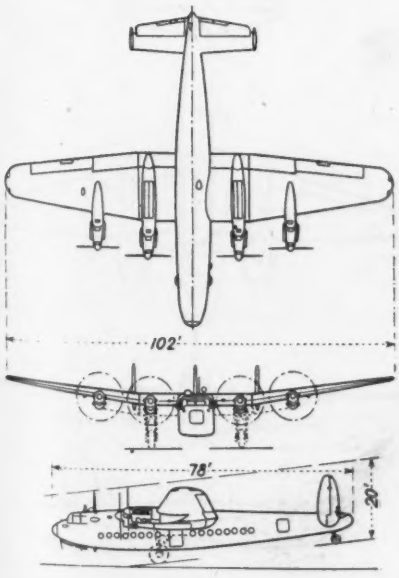
Originally designed as medium bomber, now serving as glider tug and freight transport. First British craft to go into service with retractable tricycle landing gear. High speed, 250 mph. plus; normal range, 1,300 mi., maximum payload, 4,500 lb. Powered by two 1,560-hp. Bristol Hercules. Gross wt., 36,500 lb.





Avro Lancaster III

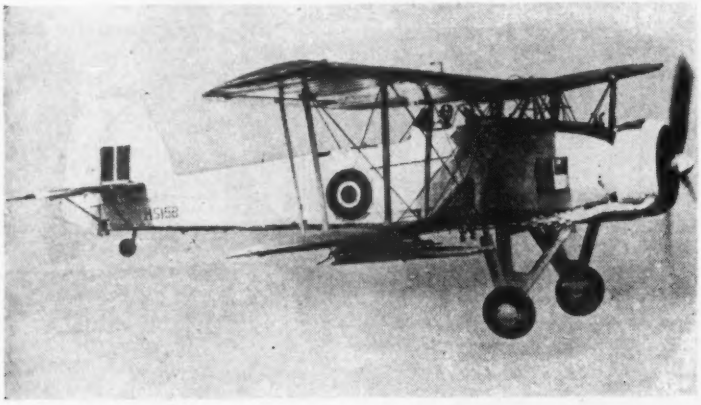
Principal difference from Mark II, which is powered by four 1,650-hp. Bristol Hercules, is installation of four 1,280-hp. Rolls-Royce Merlin XXVIII's. Produced in Canada and Australia as well as England. High speed, approximately 300 mph., maximum range, 3,000 mi., gross wt. ranges up to 60,000 lb.

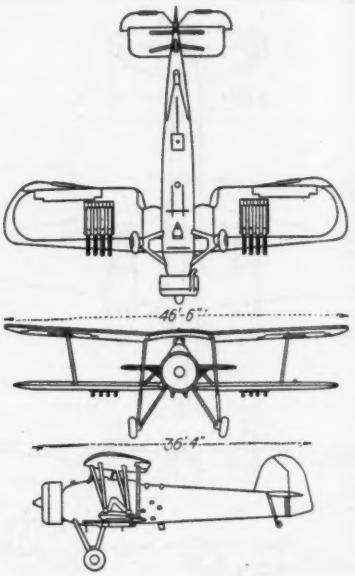


Avro York I

Built around Lancaster I wings, power plant and landing gear, York fuselage is 9 ft. 2 in. longer than bomber's, and triple vertical fins have been installed for added stability. Carries total of 24 passengers and crew of four. High speed is around 300 mph., normal fuel capacity, 2,480 gal., giving range of about 3,000 mi.

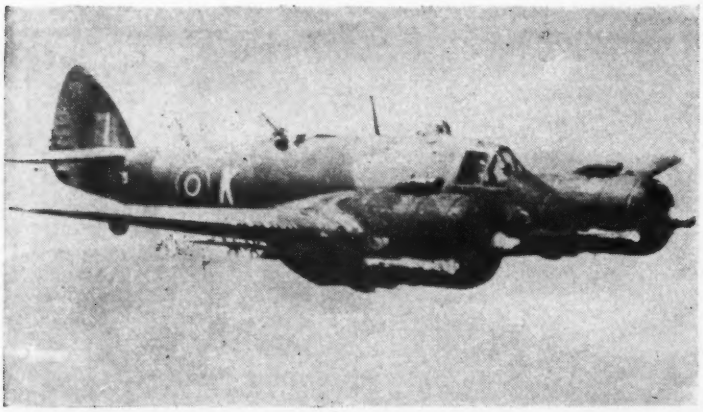
BRITISH

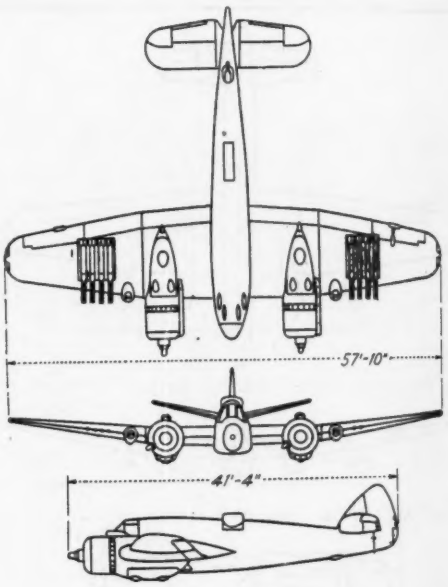




Blackburn Blackfish

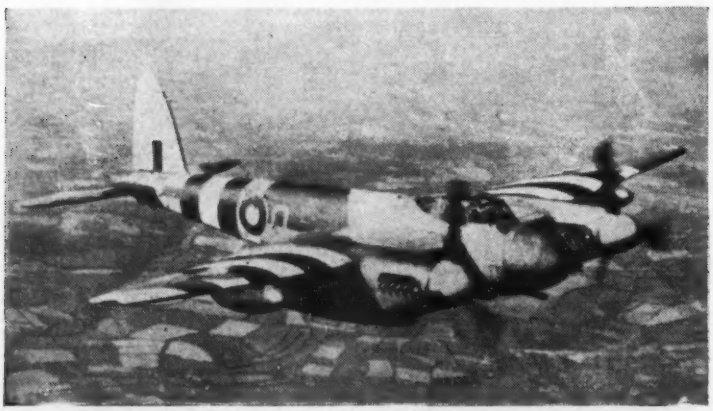
The old Fairey Swordfish being built by Blackburn. Has been constantly used for wide variety of missions including coastal and anti-submarine patrol, air-sea rescue work and reconnaissance. Now armed with rockets. High speed, 140 mph., cruising speed, 120. Power, one 775-hp. Bristol. Gross wt., 7,720 lb., empty, 4,500.

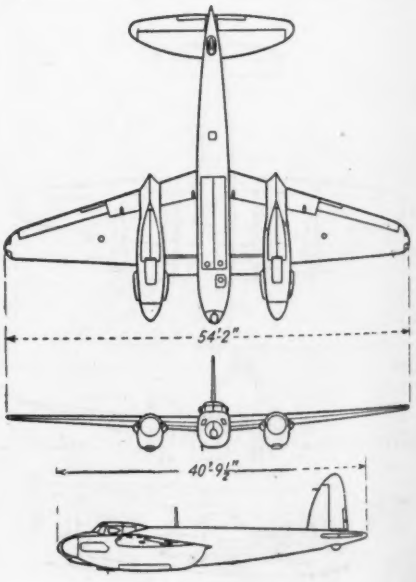




Bristol Beaufighter III

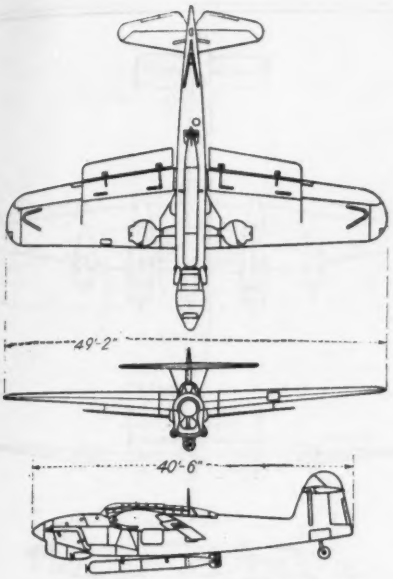
Two-place fighter-bomber now used extensively on coastal patrol and on missions against Nazi shipping, armament including rockets in addition to 20-mm. cannon in nose and six 303-cal. machine guns in wings. High speed, 352 mph., maximum range, 1,300 mi. Power, two Bristol Hercules of 1,650 hp. at sea level.

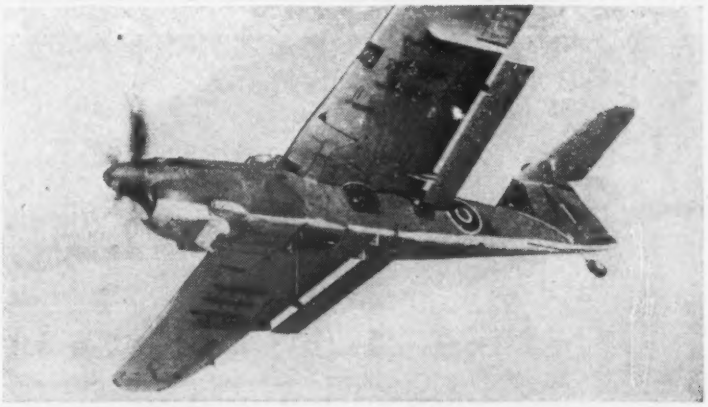




de Havilland Mosquito IV

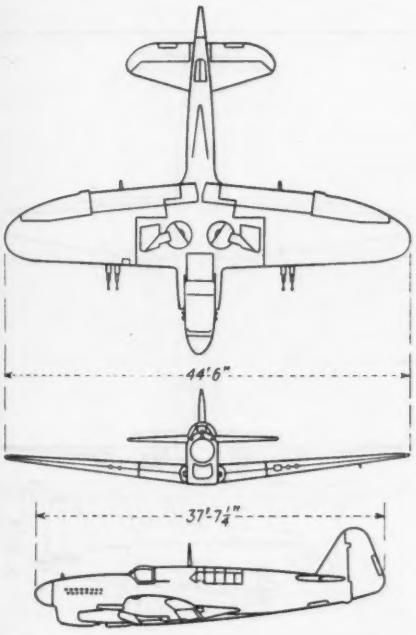
One of Britain's most versatile planes, has served as fighter, bomber and photo-reconnaissance craft. Some have been equipped with 75-mm. cannon, following American B-25 developments; others, unarmed, carry a 4,000-lb. bomb. High speed, over 400 mph. Two Rolls-Royce Merlin XXI engines of 1,280 hp.

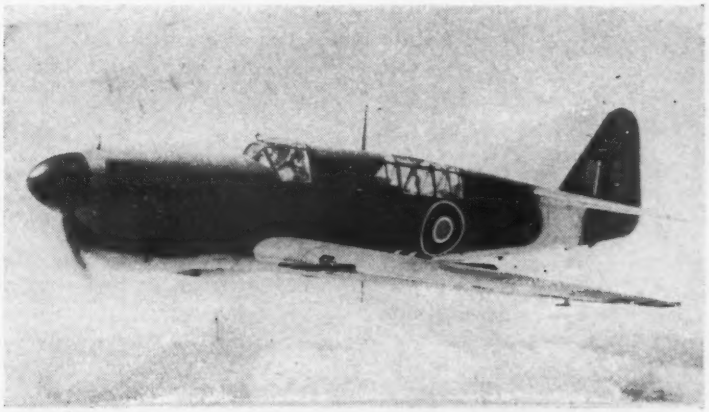




Fairey Barracuda

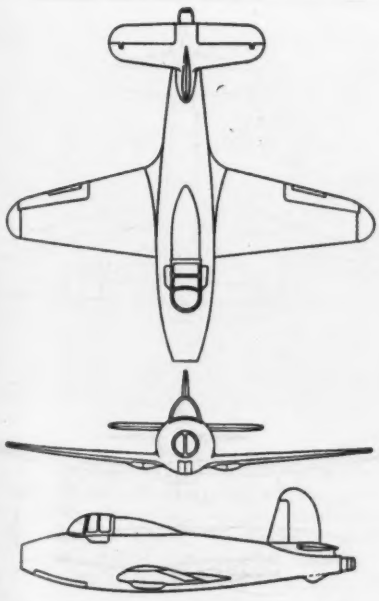
Designed for carrier operation, carrying one torpedo externally, or bombs or mine under the wings. Carries crew of three. Youngman-type dive flaps are set below trailing edge. Wings fold back against fuselage side after flaps and aft part of wing are folded over. No performance data has been made available.





Fairey Firefly

Carrier-borne reconnaissance-fighter armed with four 20-mm. cannon in the wings. Wings are folded manually for carrier stowage. Flaps are same type utilized on Barracuda. First mission was against Nazi battleship Tirpitz, later sunk by heavy bombers. Power, Rolls-Royce Griffon II engine of about 2,200 hp.



Gloster Jet Fighter

Built around single Whittle gas turbine unit set in fuselage center after fashion of old Italian Caproni-Campini, with pilot's cockpit set above propulsive unit. One of Britain's first jet fighters, it has been reported in action against Nazi buzz-bombs. No performance or design data have been released to date.

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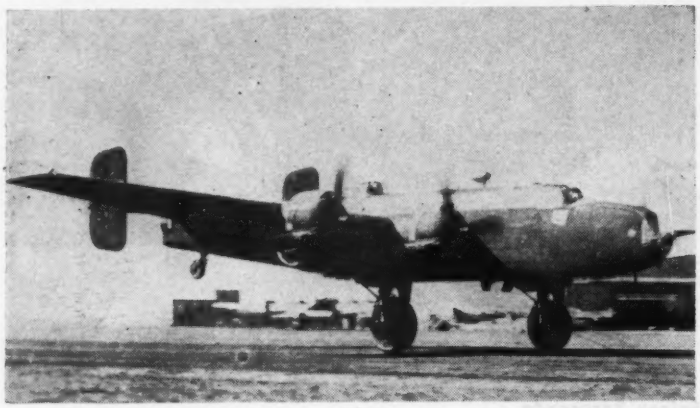
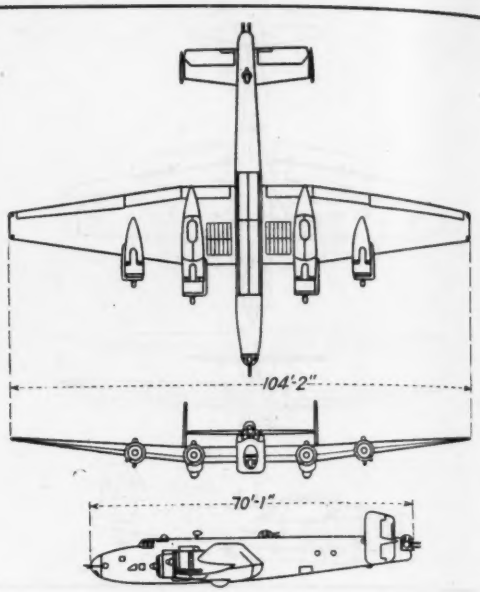
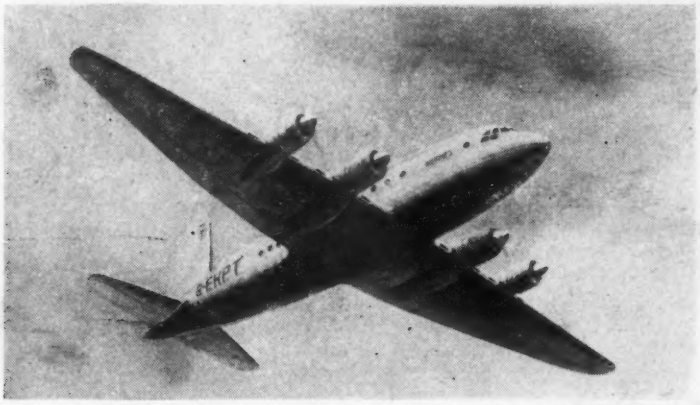
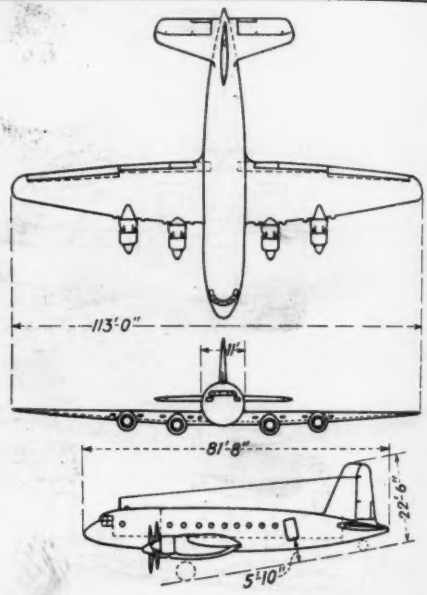




Handley Page Halifax III

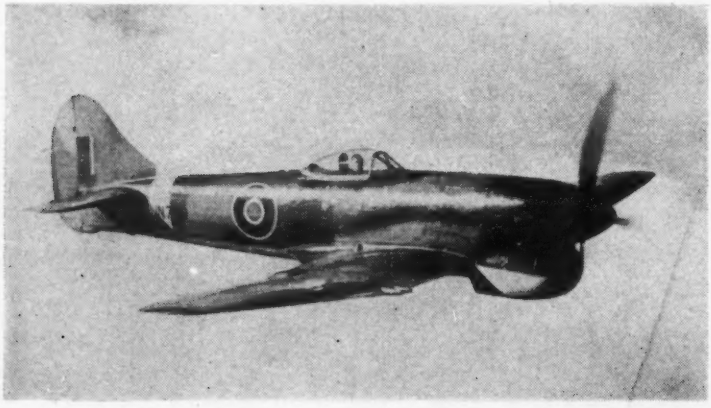
Wingspan is greater than Mark I and II—which had 98 ft. 10 in. —and 1,650-hp. Bristol Hercules XVI engines replace Rolls-Royce Merlin XXII's. Enlarged vertical fins for greater stability, installed on Mark II series, is continued. High speed is about 300 mph., maximum range about 300 mi., gross wt., 60,000 lb. plus.

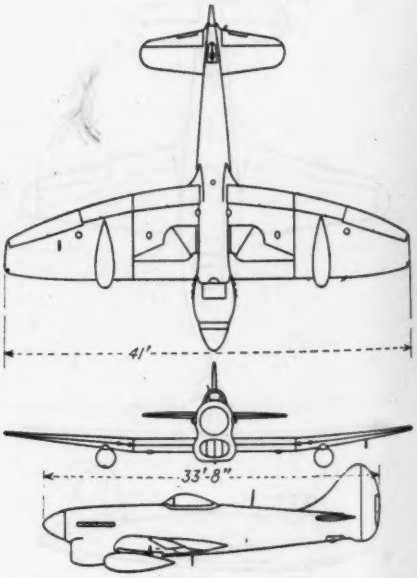




Handley Page Hermes

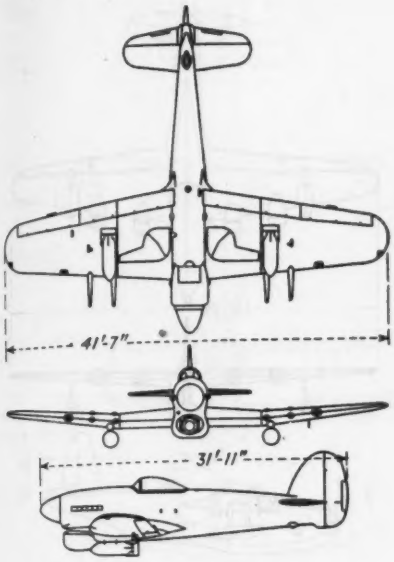
Prototype under development in bid for postwar transport market. One version to seat 34 day passengers; a deluxe version 20; another, 50 for short hauls; another, 32 by day and 16 in berths by night. High speed estimated at 340 mph., maximum range 2,000 mi. Power, four 1,600-hp. Bristol Hercules.





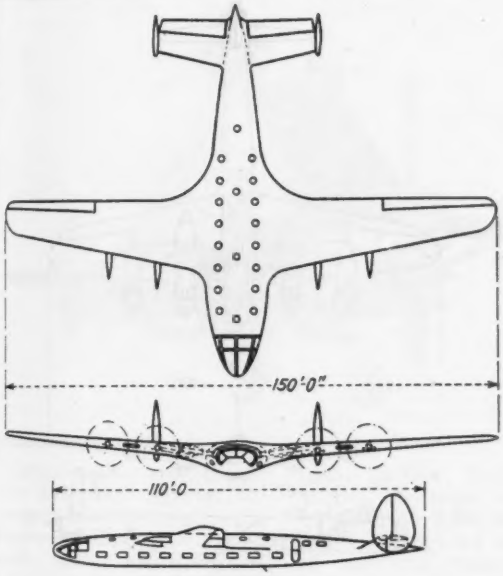
Hawker Tempest V

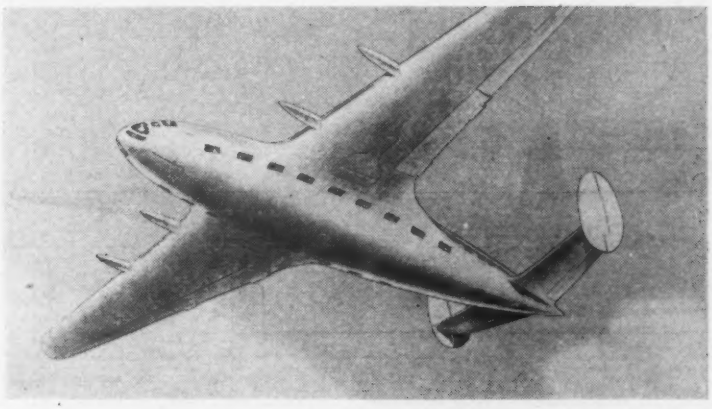
Developed from Typhoon, used largely as night fighter and against ground targets. Armament, four 20-mm. Hispano-Oerlikon cannon. Has laminar flow wing section, and high speed is over 400 mph. at 5,000 ft. Powered by a 2,200-hp. Napier Sabre IIa H-type 24-cylinder liquid cooled engine.



Hawker Typhoon R.P.

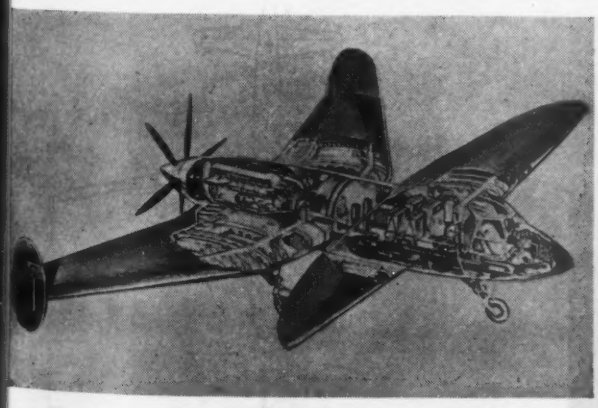
Like its successor Tempest, it is used largely for low-level and ground attack fighting, and is now armed with eight rockets, which may be fired in pairs or in salvo, in addition to four 20-mm. cannon. High speed, about 400 mph. Powered by 2,200-hp. 24-cylinder Napier Sabre H-type liquid cooled engine. Range about 500 mi.





Miles "X" Transport

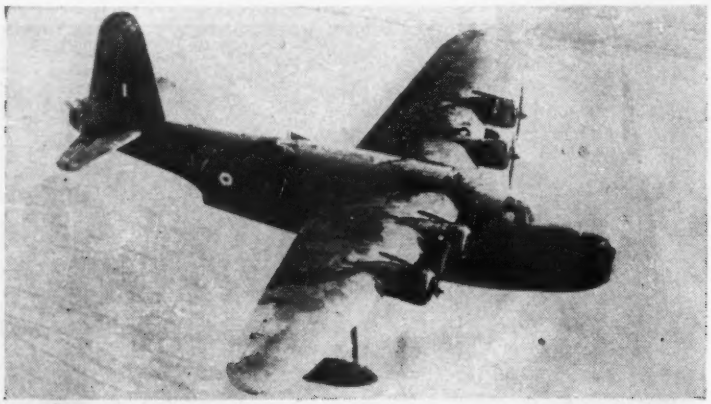
Projected postwar cargo and passenger carrier of 130,000-lb. gross wt., designed to carry 100 passengers 2,000-2,500 mi., greater numbers on shorter hauls. Central portion of passenger cabin will be 16 ft. wide. To be powered by eight 1,750-hp. Rolls-Royce engines buried in wings, driving four propellers.

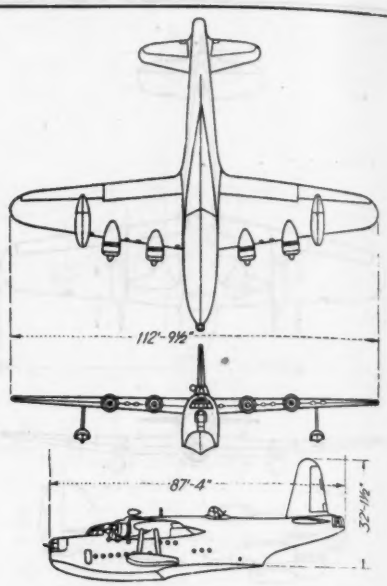


Miles Canards

Cut-away sketch (above) of proposed Miles 35 ship-board canard-type fighter. By placing pilot immediately ahead of small front stabilizing wing, forward visability is unimpaired and design permits installation of heavy free-firing armament. This design calls for installation of liquid-cooled engine turning contra-rotating pusher propeller. Above, is flying scale model—about half-size—of the Model 35 built for test purposes. Scale model employed four-wheel fixed landing gear, but 35 would have retractable tricycle gear. (For discussion of canard types by Geo. Miles, designer of these planes and a twin engine type, see "Shape of Things To Come," Aviation, September, 1944.)

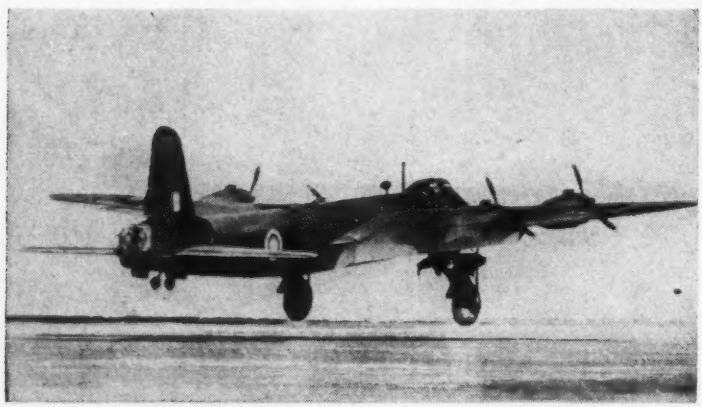
BRITISH

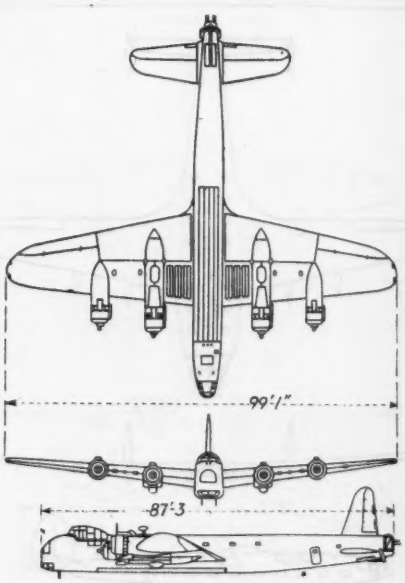




Short Sunderland III

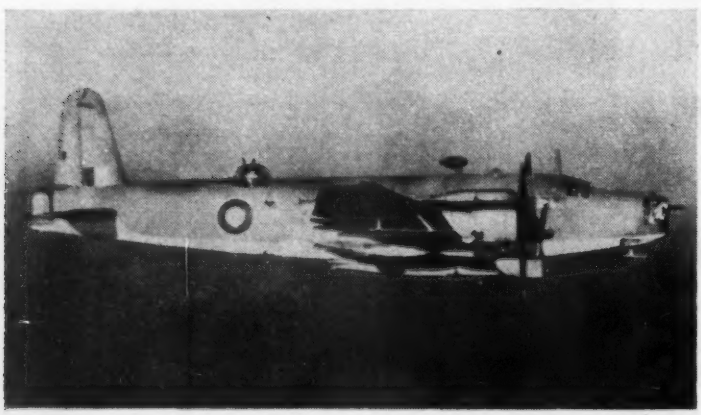
Reconnaissance-patrol bomber used for long missions. Some of type have been modified for transport work and turned over to BOAC. High speed, 210 mph., maximum range, 2,880 mi., fuel capacity, 1,520 gal., service ceiling, 20,500 ft., gross wt., 45,700 lb. Power, four 1,010-hp. Bristol Pegasus aircooled radials.

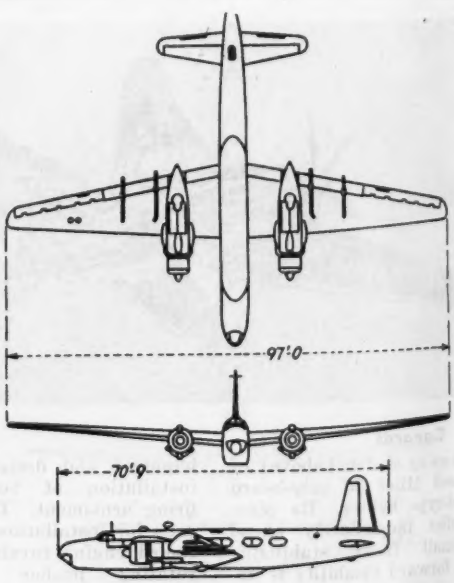




Short Stirling III

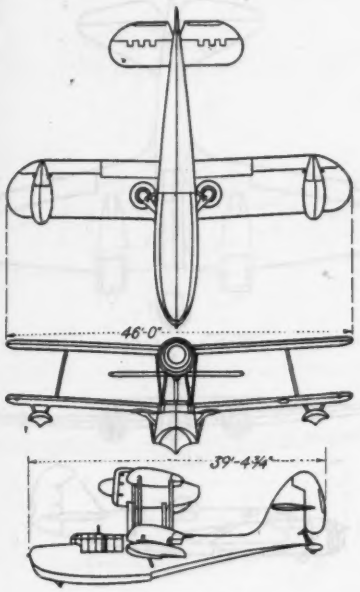
First of Britain's heavies, for a time used almost exclusively on mine laying operations. Has also served as transport and glider tug. High speed, about 300 mph., cruising speed, 200 mph., range, 2,000 mi., gross wt., 70,000 lb., wt. empty, 46,000 lb. Power, four 1,650-hp. Bristol Hercules XVI's. Carries crew of six or seven.

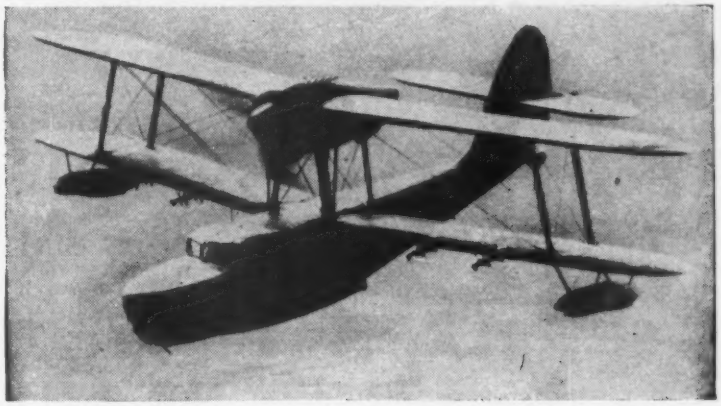




Vickers Warwick

Developed from Vickers Wellington bomber, this transport also has geodetic construction. Considerably larger than its predecessor it has wing area of 1,006 sq. ft., against 750 for Wellington, and has gross wt. of 45,000 lb. Powered by either 1,850 or 2,000-hp. Pratt & Whitney R-2800's. Has range of about 2,500 mi.



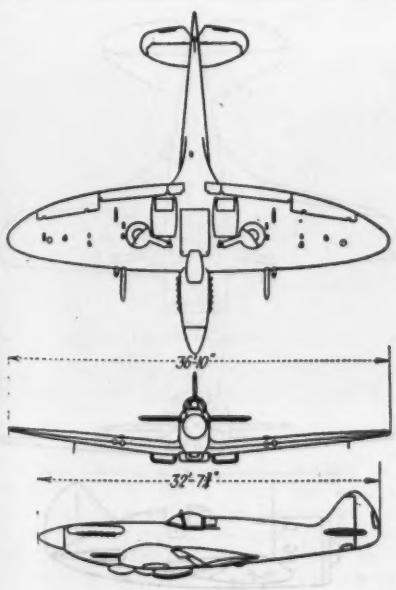


Vickers Sea Otter I

Developed from Supermarine Walrus, is used as ship-based reconnaissance craft by Royal Navy and for air-sea rescue by RAF. Hull is all-metal; wings and tail surfaces have metal spars and wood ribs, fabric-covered. Carries crew of three. Gross wt., 9,150 lb. Powered by one 870-hp. Bristol Mercury 30.

Vickers Seafire III

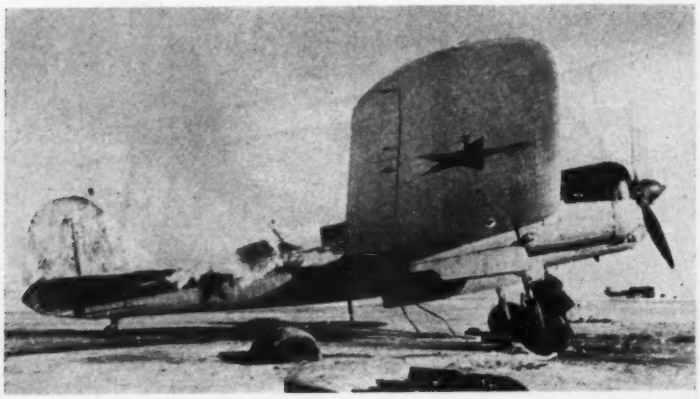
Carrier-based version of "Old Evergreen" Spitfire interceptor modified for seagoing photo-reconnaissance or fighter work. Seafire was developed from Spitfire Vc, but is heavier, its gross wt. standing at about 8,000 lb. against 5,850. Outer wing panels fold up and over fuselage while wingtips fold down to horizontal position to make hangar deck stowage possible. Armament generally consists of four 20-mm. cannon, but may be varied to consist of machine guns or combination of cannon and machine guns. Powered by 1,470-hp. Rolls Royce Merlin LV.

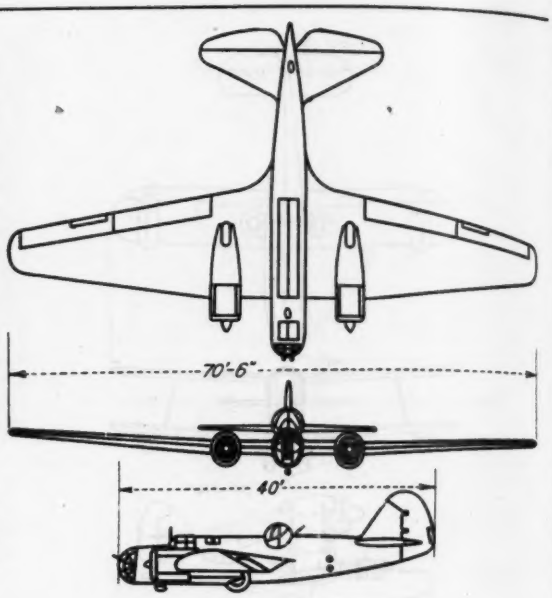


Vickers Supermarine Spitfire XIV

Powered by 2,000-hp. pressure-cooled Rolls-Royce Griffon with two stage supercharger, has service ceiling of over 40,000 ft. Has five-bladed constant-speed Rotol propeller. Armament varies between four 20-mm. cannon; two cannon and two 50-cal. machine guns or two cannon and four 303's. High speed, over 400 mph.

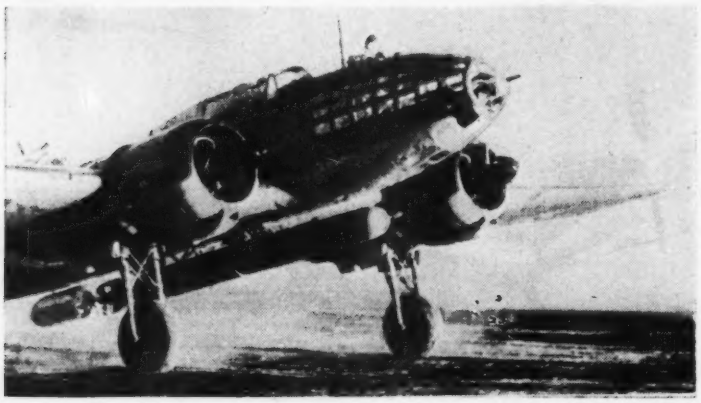
RUSSIAN

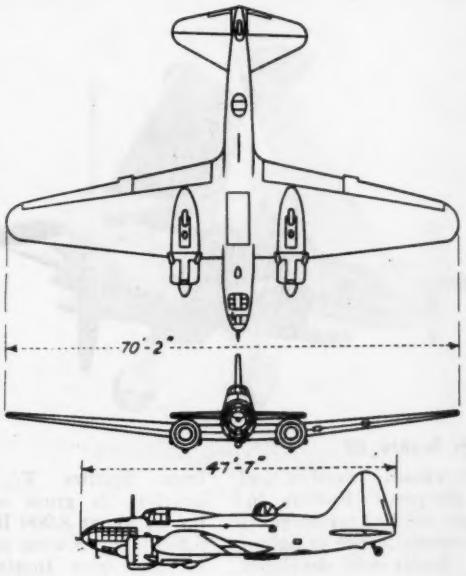




DB-3

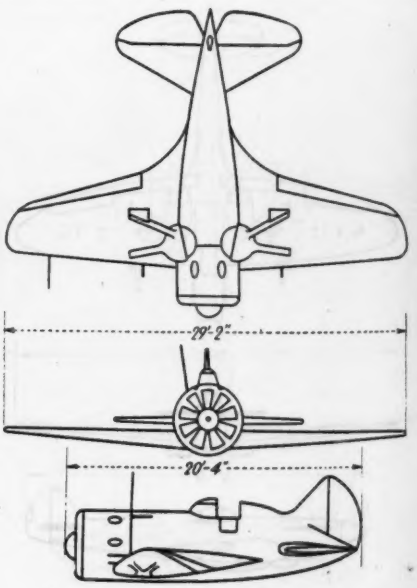
Ilyushin-designed medium bomber powered by 950-hp. M-87b radial engines, carrying crew of three or four. Armament consists of machine guns in fuselage nose and single, hand-operated machine gun in dorsal position. High speed, about 280 mph. at 10,000 ft., maximum range, 2,500 mi., gross wt., 30,000 lb.





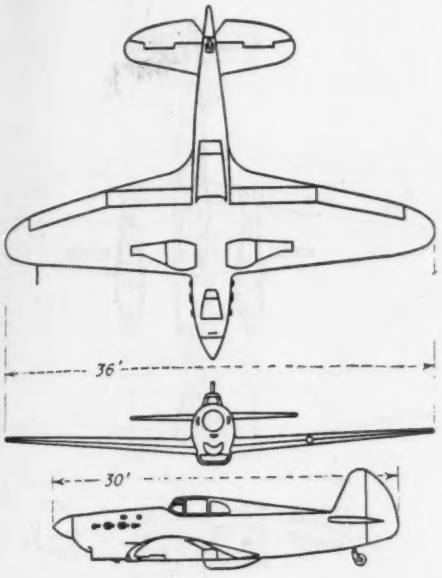
DB-3F

Direct development of DB-3, powered by two 1,100-hp. M-88 radical engines. Also carries crew of three or four and has power turret in dorsal position. High speed about 270 mph. at 16,000 ft., cruising speed, 186 mph., range about 2,000 mi., service ceiling, 30,700 ft., gross wt., 33,000 lb. or more.



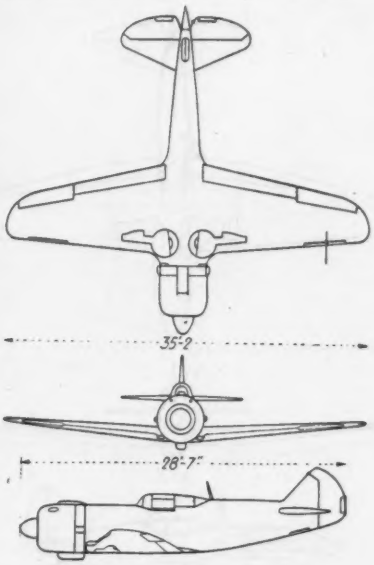
I-16

Developed from old Boeing P-26, this craft saw extensive service in Spanish Civil War and was kept in operation in current war. Two-seater version has been used as advanced trainer. Armament reported to consist of two 20-mm. cannon and four 50-cal. machine guns. High speed, 300 mph., power, 1,100-hp. M-88.



Lagg-3

Lavochkin - designed all - wood fighter powered by a 1,100-hp. M-105p 12-cylinder liquid-cooled V-type engine. High speed, 348 mph. at 16,500 ft., cruising speed, about 280 mph., climb, 2,000 fpm., landing speed, 87 mph., range, about 400 mi. Armament, 20-mm. cannon and two 12.7-mm. machine guns.

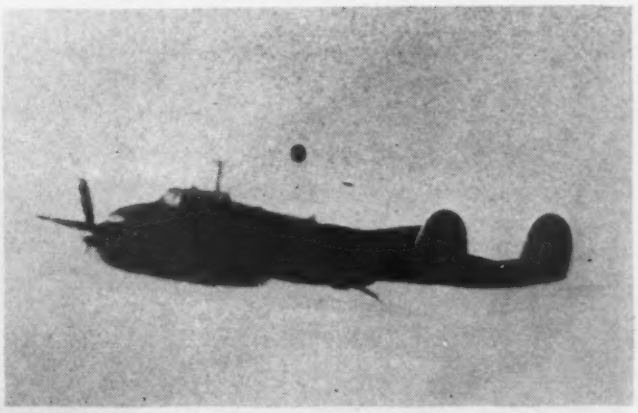


LA-5

Direct development of Lagg-3, some later models have slightly raised cockpit for better visibility. Powered by twin-row radial—it is one of Red Air Force's few air-cooled fighters—of better than 1,600-hp., high speed is around 400 mph. Gross wt., 7,480 lb., wt. empty, 6,090 lb. Mixed wood-metal design.

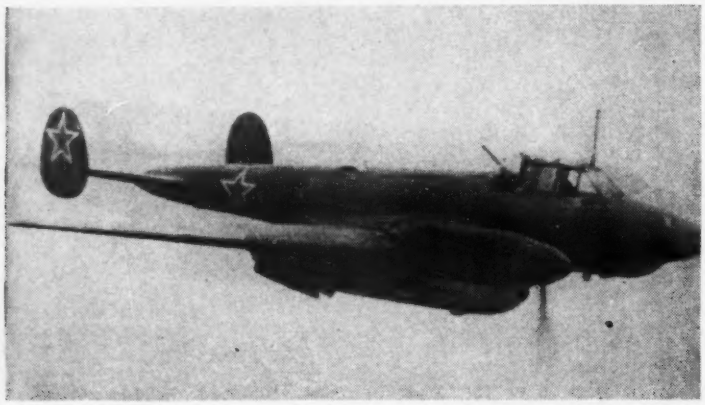
Modified MIG

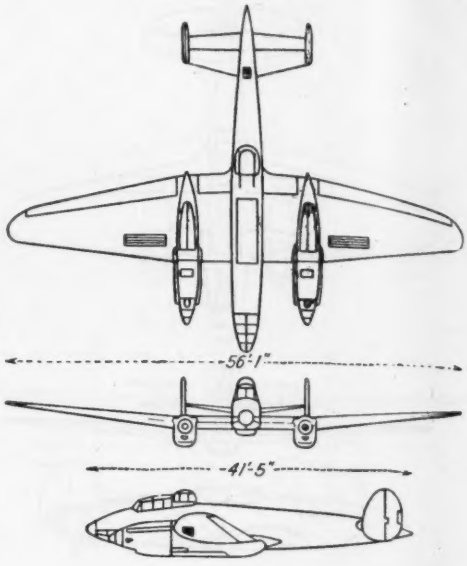
Believed to be a development of the MIG-3, this new Red Air Force fighter has a twin-row radial aircooled engine probably turning up 1,600 hp. or more. Principal modifications appear to lie in provisions for heavier armament—at least four guns in cowling—and installation of new engine which should give high speed well above 370 mph.



Yak-4

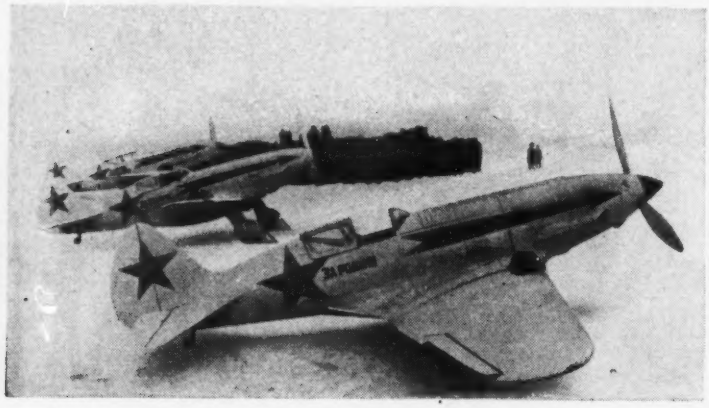
Yakovlev - designed fighter, bomber, reconnaissance craft powered by two 1,100-hp. M-105 liquid cooled V-type engines. Carries crew of two. Armament consists of one movable and two fixed machine guns; also reported used as dive bomber. High speed about 315 mph. Yak-4 is understood to be of mixed wood-metal construction.

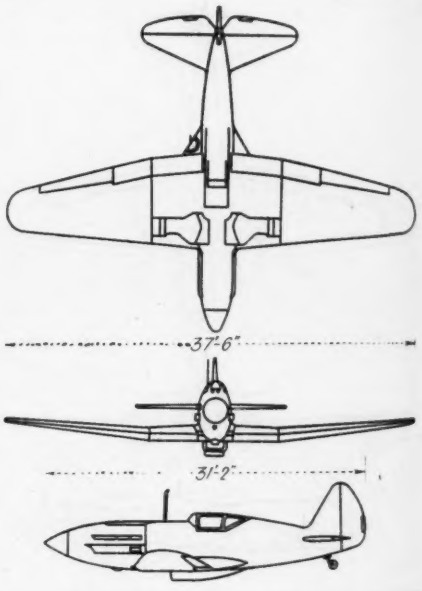




PE-3

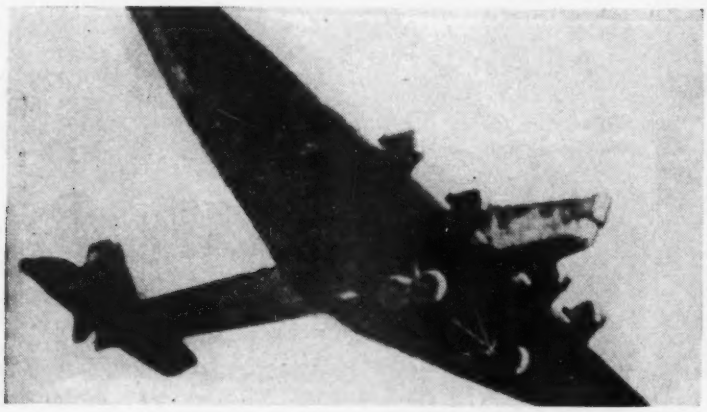
Principal outward difference from PE-2 is installation of power turret in place of hand-operated machine gun firing aft just behind pilot. As in PE-2, bombardier is prone in nose below pilot. It is possible PE-3 has slightly higher powered engines giving somewhat better performance than earlier type.

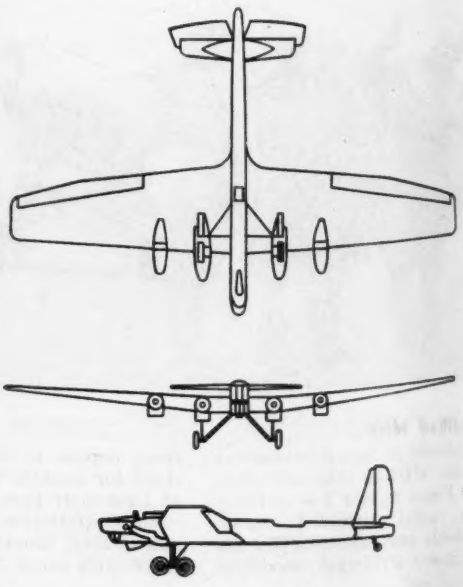




MIG-3

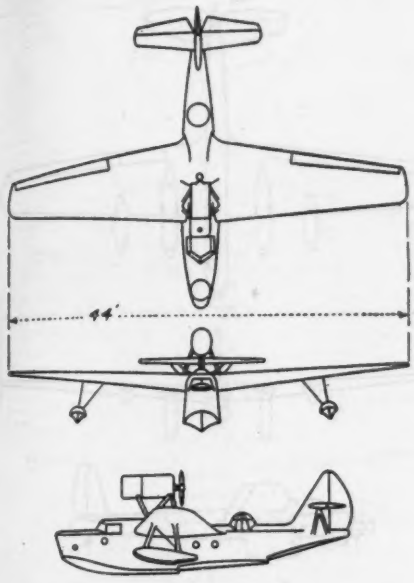
All-metal fighter-bomber widely used by Red Air Force with excellent results. Powered by AM-35A liquid cooled engine of 1,250 hp. at 19,680 ft., has high speed of about 380 mph. Gross wt., 6,200 lb. Armament varies widely. Successor types are understood to have engines developing up to 1,600 hp.





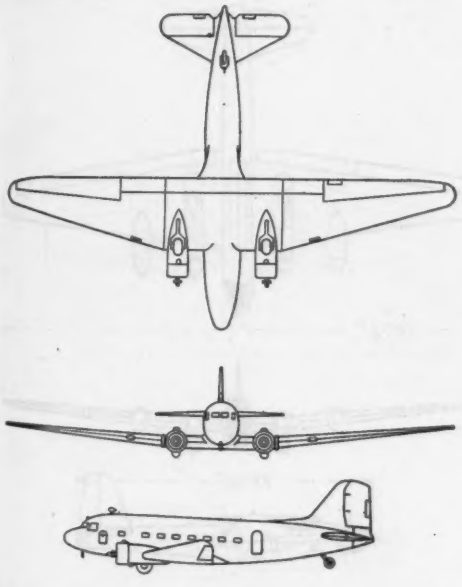
TB-3

Toupolev-designed bomber now obsolete for combat, understood to be used exclusively for cargo transport. Powered by four 830-hp. Hispano-Suiza type M-34's, top speed is only 125 mph., cruising speed, about 95 mph. Interesting for its use of tandem wheels on fixed main landing gear.



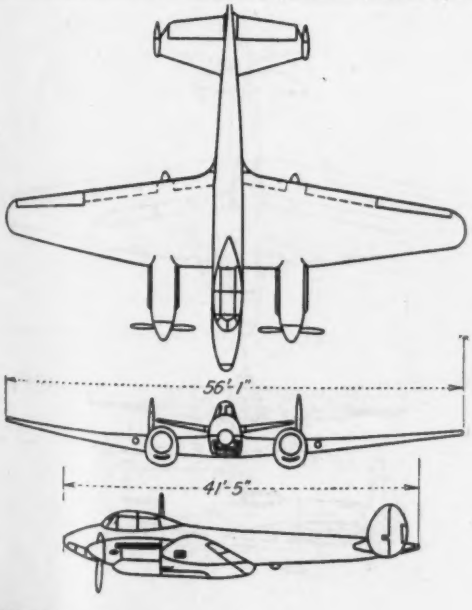
MBR-2

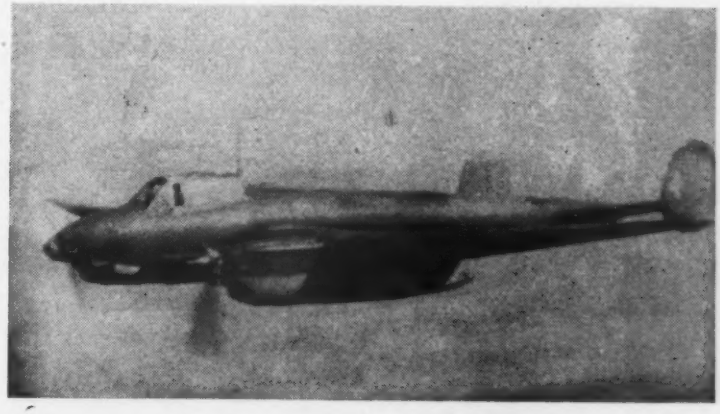
Three-to-five place single engine reconnaissance flying boat. Powered by 680-hp. M-17 BMW, craft has high speed of 140 mph., service ceiling of 17,000-odd ft., range of 620 mi. Armament consists of machine guns set in bow cockpit and in dorsal turret set just aft of wing trailing edge. Used in Black and Baltic seas.



PS-84

None other than the Douglas-designed DC-3, built in the Soviet under a prewar license agreement. Originally produced for service on Russian transport lines, it has gone into military service. Powered by two, 1,100-hp. M-63 engines, which are probably Wright Cyclones also built under license.





PE-2

Widely used three-place reconnaissance bomber powered by two 1,100-hp. liquid cooled M-105 V-type engines giving high speed of about 310 mph. Of all-metal, flush-riveted construction. Armament consists of two heavy caliber machine guns in nose, others firing aft from cockpit and from ventral position.

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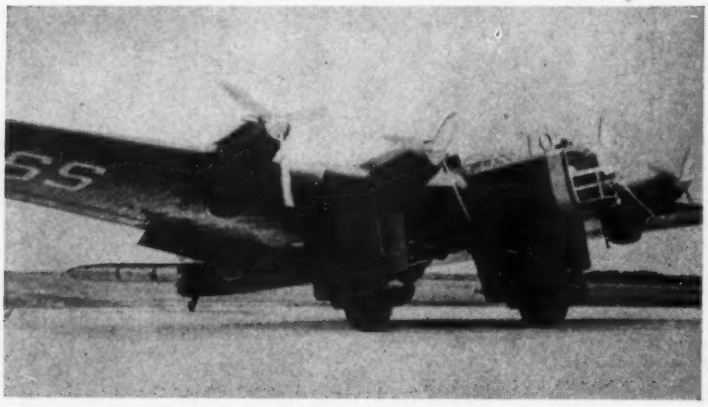
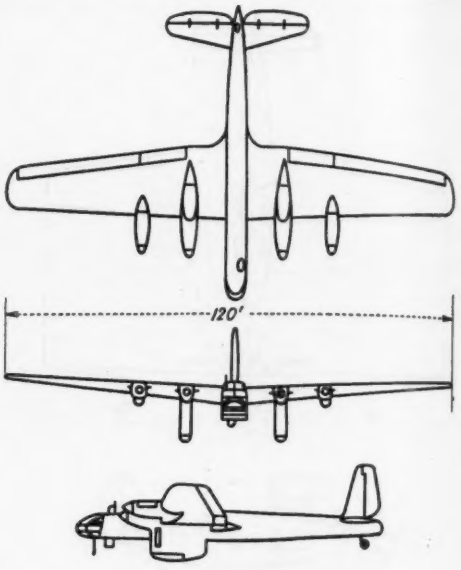
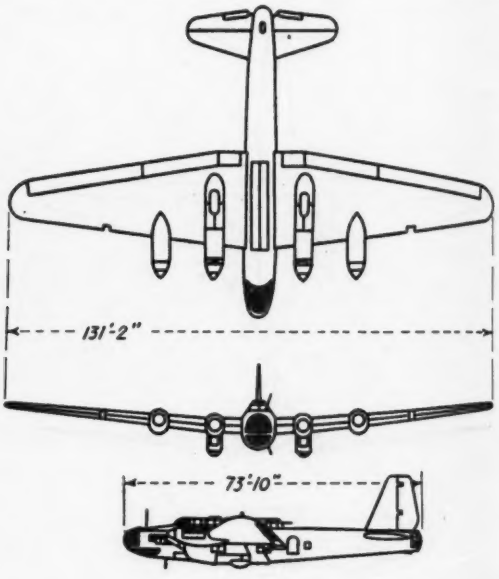




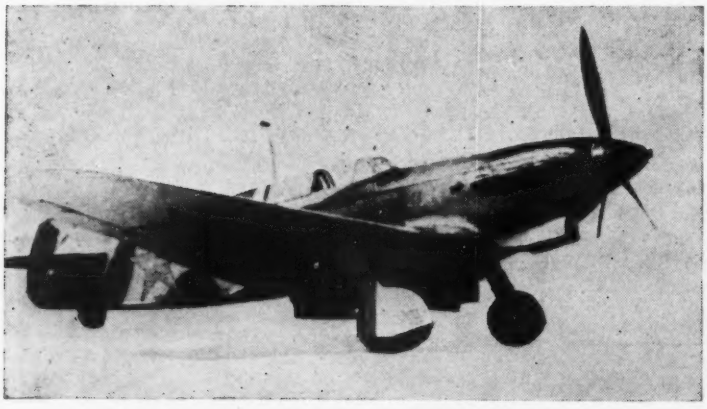
TB-6B

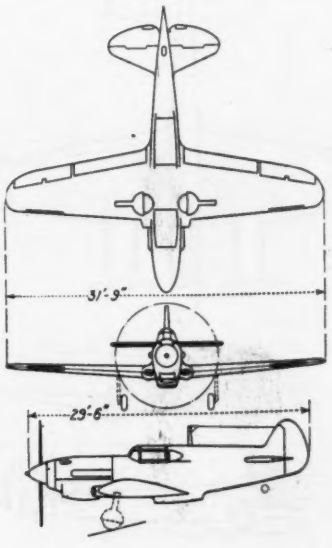
Eight-place heavy bomber, forerunner of TB-7. Powered by four 1,100-hp. Hispano-Suisa type M-100 liquid cooled engines giving high speed of about 230 mph., and having service ceiling of approximately 26,000 ft. Has two-stage superchargers. Gross wt., 50,000 lb. Semi-retractable landing gear.



TB-7

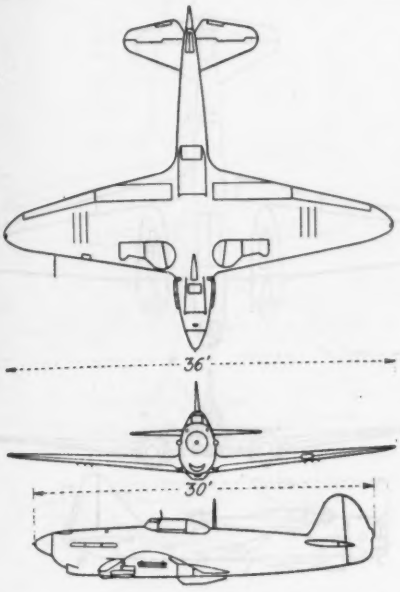
Eleven-place heavy bomber, powered by four 1,300-hp. liquid cooled AM-38 engines giving top speed of 280 mph. at 25,000 ft., cruising speed of 210. Service ceiling, 25,000 ft. Gross wt., 49,280 lb. Craft is reported to have been modified by installing more powerful radial aircooled engines.





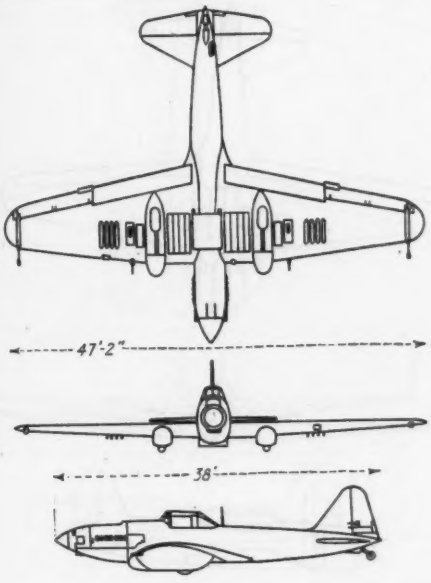
YAK-1

Yakovlev-designed all-metal fighter powered by 1,200-hp. 12-cylinder liquid cooled AM-35A engine with two-stage supercharger, giving high speed of 360 mph. Some of the type have cannon firing through propeller hub plus machine guns; others have eight machine guns mounted in wings.



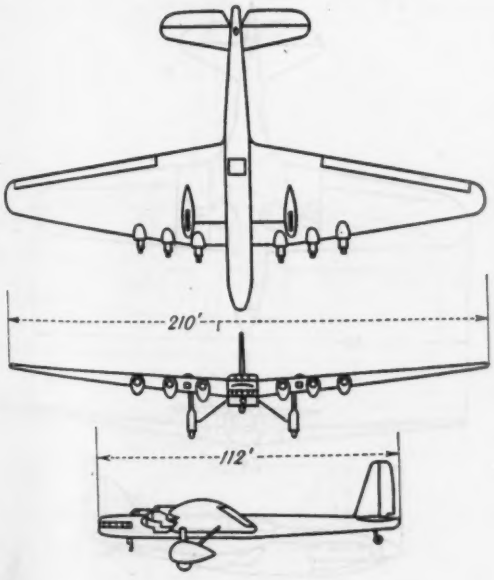
YAK-9

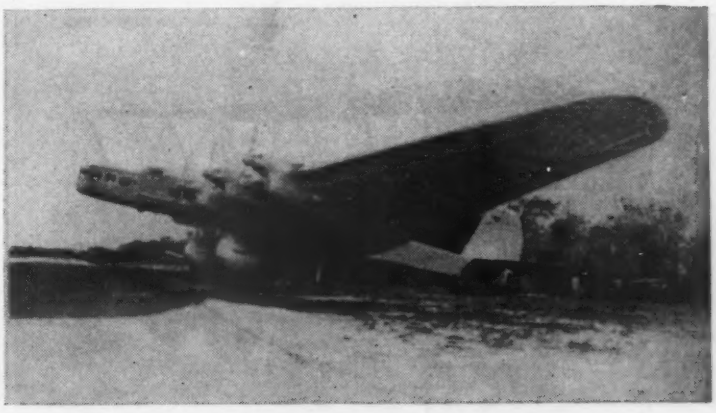
Latest development of Yak fighter series, this model has cockpit canopy raised above fuselage for better visibility, and is reported a very maneuverable craft. Powered by 1,100-hp. 12-cylinder liquid cooled V-type M-105p, it has high speed of about 345 mph. Gross wt. is 6,000 lb.



IL-2 Stormovik

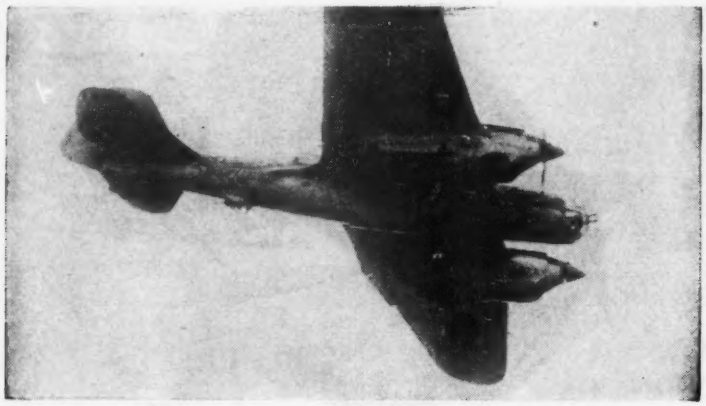
Low-level attack bomber carrying crew of one or two, powered by one 1,300-hp. liquid cooled AM-38 giving top speed of 280 mph. A modified version, IL-4, having different type canopy, has high speed of 258 mph. Bomb loads range up to 1,000 lb. Extensively used as rocket bombing craft.

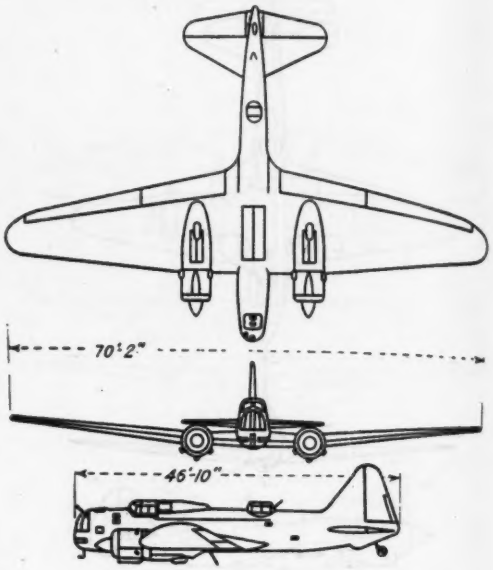




L-760

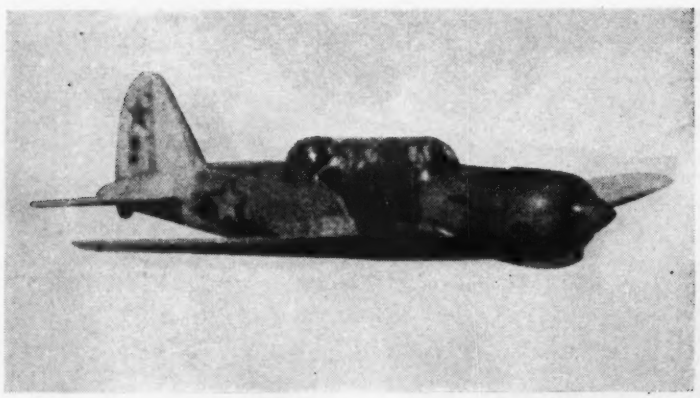
Toupolev-designed craft developed from Maxim Gorky type for peacetime transport work. Powered by six 1,100-hp. liquid cooled Hispano Suiza type M-100's, has high speed of 185 mph., normal range of 1,860 mi. Gross wt. is 103,000 lb. Originally designed to have capacity for 64 passengers.

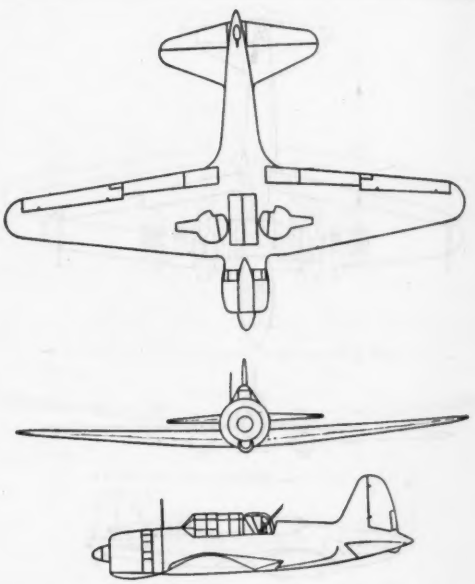




SB-3

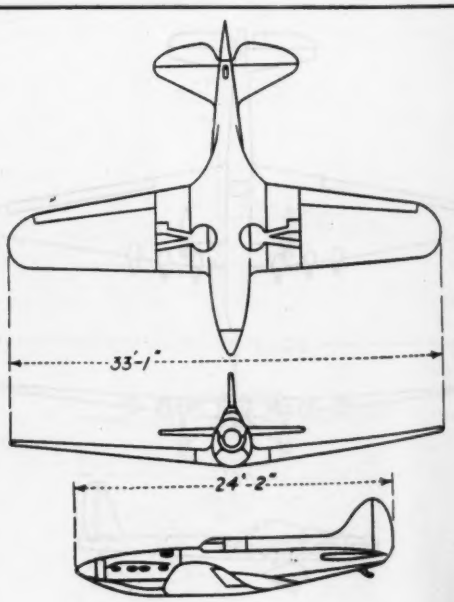
A "workhorse" of Red Air Force, this medium bomber is improved version of SB-2. Powered by two 950-hp. liquid cooled Hispano-Suiza type M-12's, it has high speed of 280 mph., cruising speed of 220 at 14,400 ft. Armament, brace of machine guns in nose, others in dorsal and ventral turrets.





SU-2

One of earliest Red Air Force planes powered by radial engine, it bears great resemblance to Brewster Bermuda but is understood to be an independent design. Powered by 1,100-hp. M-88, has high speed of about 275 mph. Also reported modified as single seat, heavily-armed fighter plane.

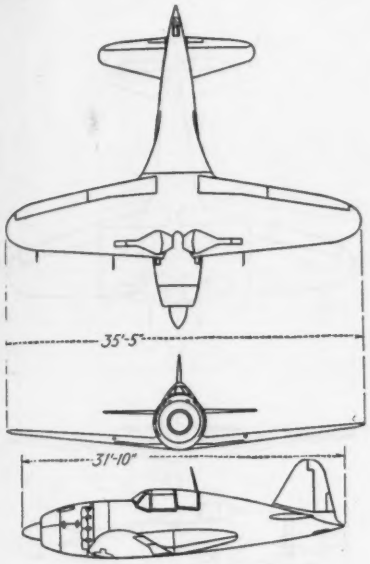


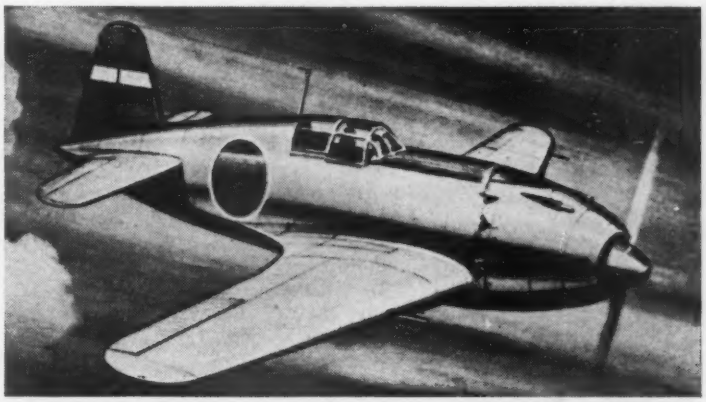
P-2 (above)

Three-place version of primary trainer designed and first built some 20 years ago. A modification has been widely used as ambulance craft.

I-17 (right)

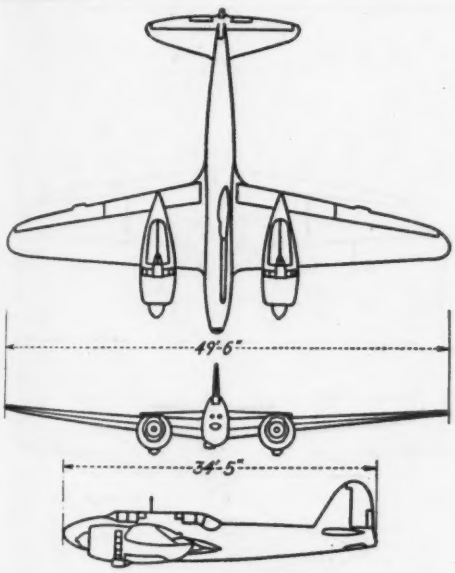
Fighter-bomber powered by 1,100-hp. Hispano-Suiza type liquid cooled M-100 engine, it has high speed of 310 mph., cruising speed of 273.

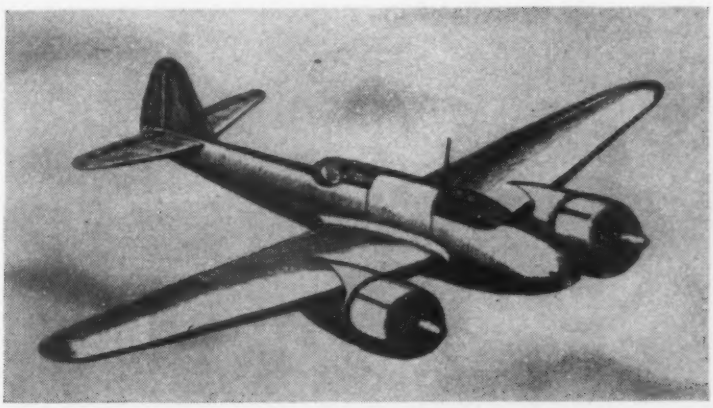




Jack 11 Navy Fighter

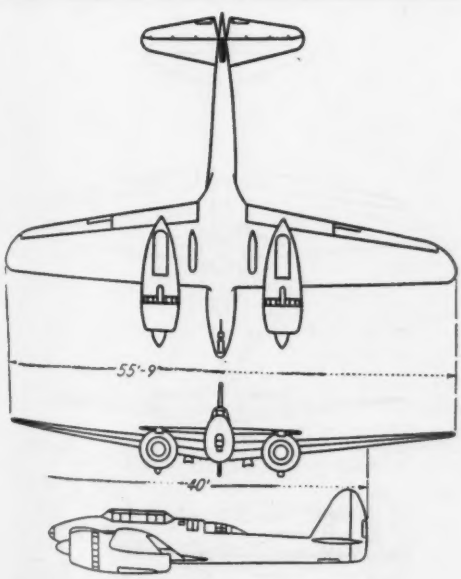
Short stubby Jack resembles Tojo, is used as interceptor. A twin-row engine of about 1,875 hp. gives Jack top speed of about 400 mph. with approximately 1,100-mile range. No armor or self-sealing tanks are reported. Armament is two 7.7-mm. and two 20-mm. guns. Ejector exhausts are fitted.

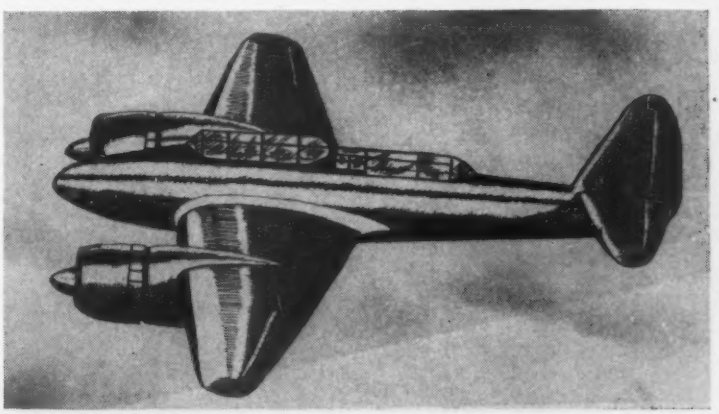




Nick 1 Army Fighter

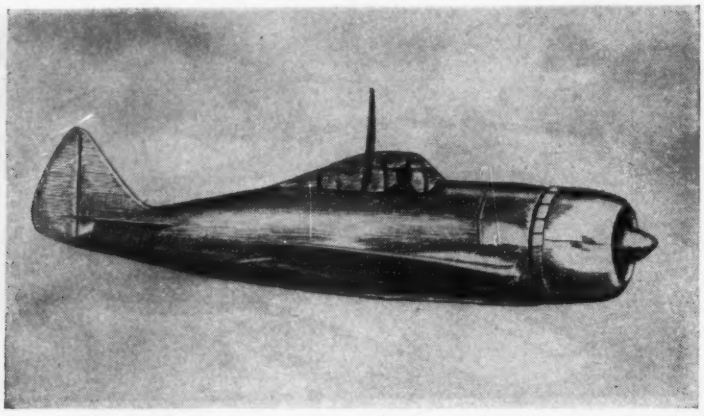
Two-place long range fighter-bomber, Nick has two Mitsubishi twin-row radials of 1,100-hp. Heavily armed with 37-mm., 12.7-mm. and 7.7-mm. guns, top speed is close to 350 mph. and range about 1,300 miles. Of late Nick has also been used as a night fighter, and has been operational in raids on B-29 Saipan bases.

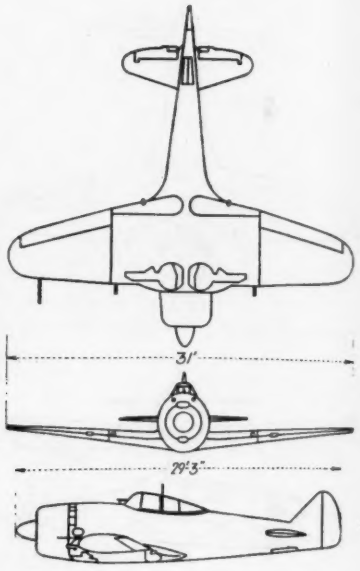




Irving 11 Navy Fighter

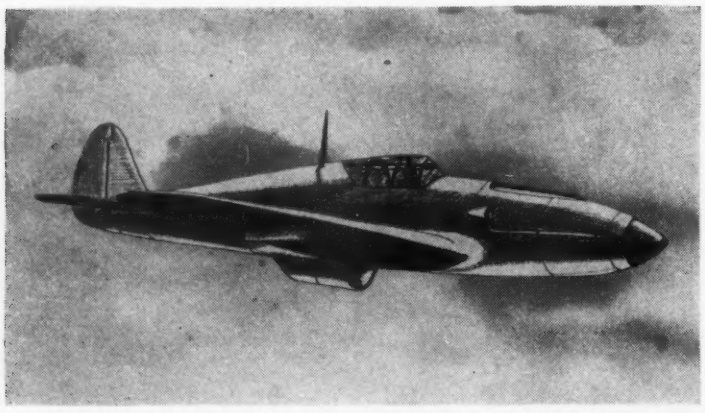
Generally similar to Nick, this type is used for same duties—night-fighter and ground attack. Powered with two Nakajima Sakae 21 radials of 1,020-hp. Armament is unknown but believed very heavy including multi high velocity 20-mm. cannon. Range is 1,900 mi. Improved Irving 21 has 330 mph. top speed.

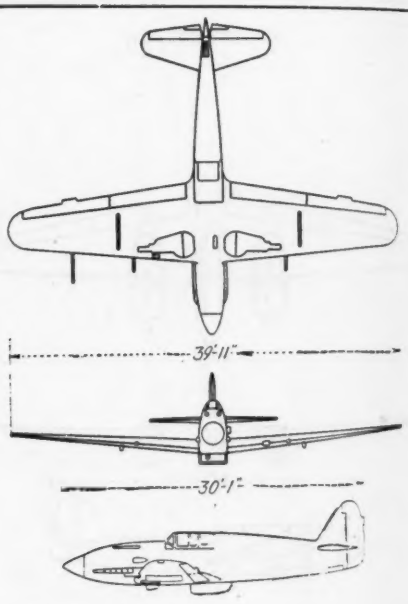




Tojo 2 Army Fighter

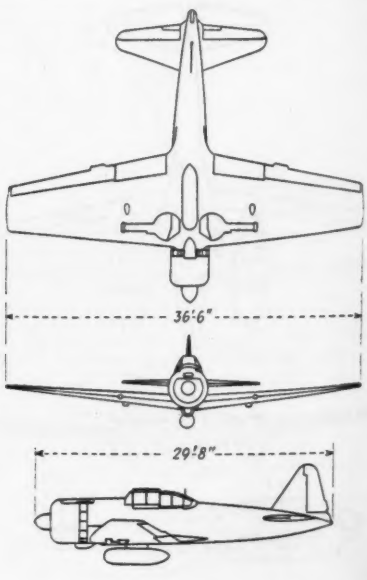
Used mainly in CBI area, Tojo has Nakajima twin-row 1,400-hp. radial, over 375 mph. top speed. First Jap type to stay in a dive with a P-47, Tojo is also very maneuverable. But armor and self-sealing tanks have not been very effective and only four 12.7 and 7.7-mm. guns comprise armament.





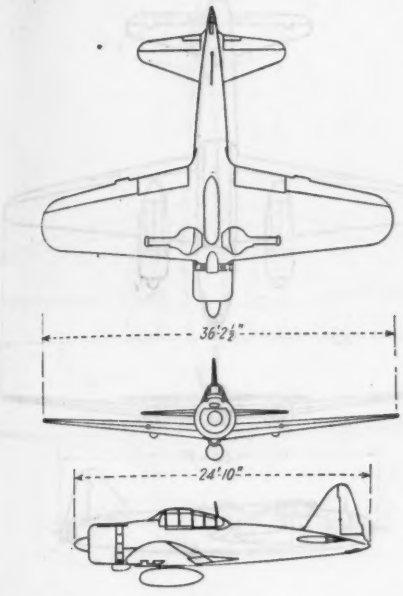
Tony 1 Army Fighter

First Jap-designed fighter with an inline engine, Tony seems to be copy of Hurricane. Kawasaki 1,100-hp. engine can be fitted with hub cannon but none seem to have been used thus far. Top speed is near 360 mph., range with extra tanks about 1,900 mi. Armament varies—some Tonies carry four 12.7 mm. guns.



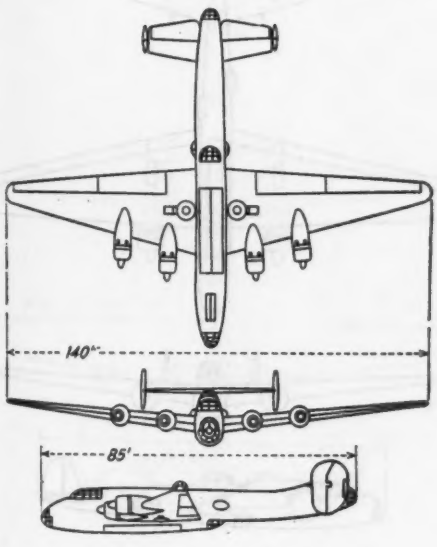
Zeke 32 Navy Fighter

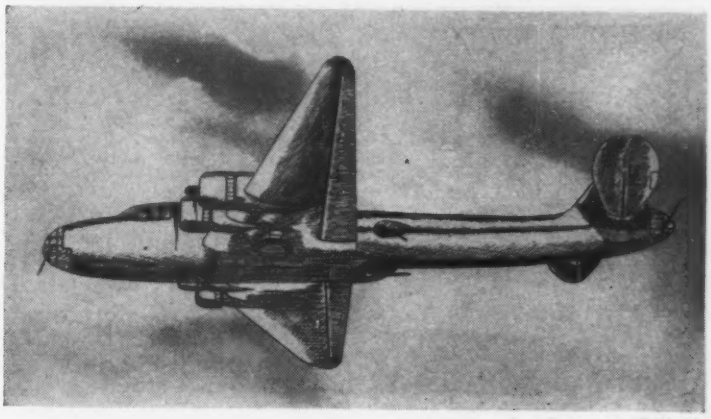
Formerly called Hamp, this type is believed out of production but still sees action. Nakajima Sakae twin-row radial gives top speed of around 350 mph., climb of better than 3,500 fpm. Low velocity armament, lack of armor or self-sealing tanks made Zeke a flying coffin for many Nip pilots. Gross wt., 5,570 lb.



Zeke 52 Navy Fighter

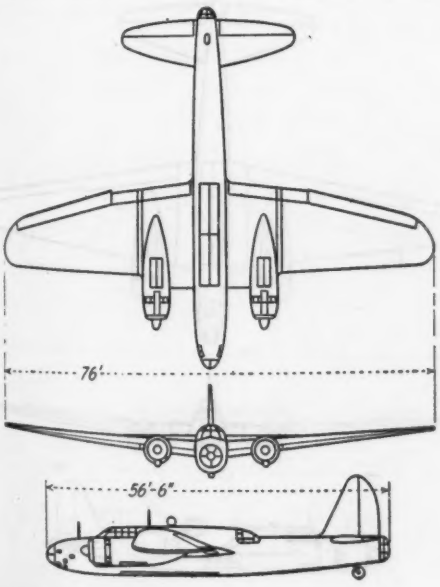
Latest version of famous Zekes has smoother lines, Nakajima Sakae radial of 1,020-hp. fitted with ejector type exhaust stacks. Top speed is over 350 mph., armament has been improved by substituting higher velocity guns. Range is about 1,500 mi. with auxiliary tankage. Smaller ailerons, smooth cowl.

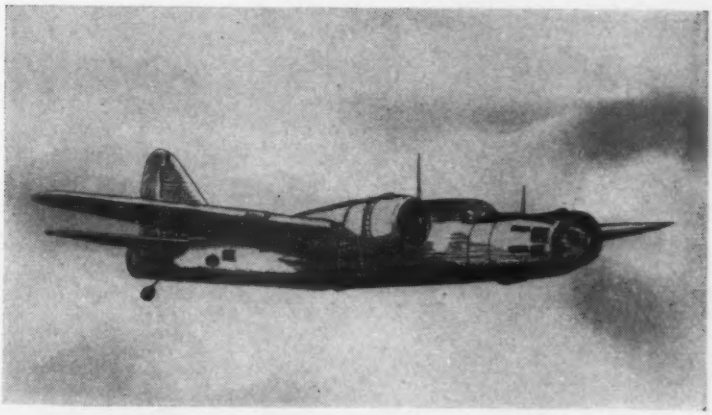




Liz 11 Navy Bomber-transport

Designed as heavy bomber type, Liz has become a Navy cargo-transport. Resembling a twin-rudder B-19, wingspan is about 115 ft., length 85 ft. First large Jap type to use tricycle landing gear. Liz appears to be well armed with machine guns and cannon. Construction all metal, engine make unknown.

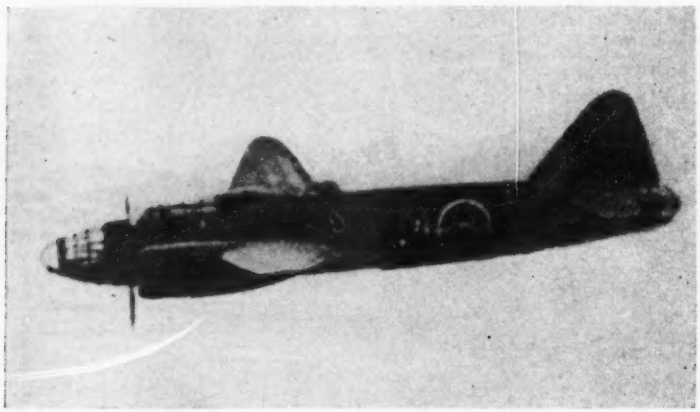


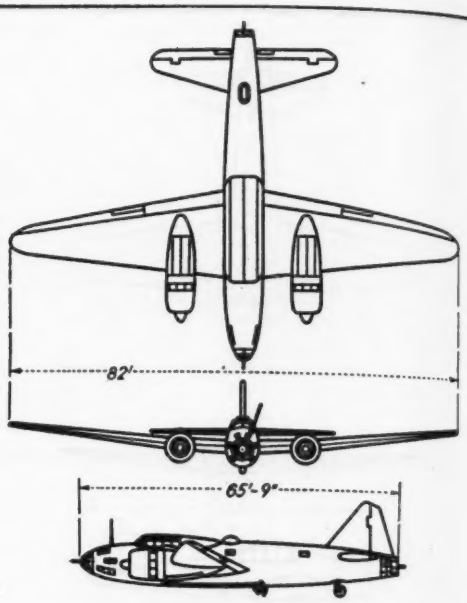


Helen 1 Army Bomber

New Jap medium bomber with a top speed near 275 mph., ceiling about 30,000 ft. Armament is 7.7-mm. mgs in nose, tail, waist and belly positions and a 20-mm. cannon in top turret. Leading edge of center section comes forward as on DH Mosquito. Powered by two Nakajima type Two radial engines.

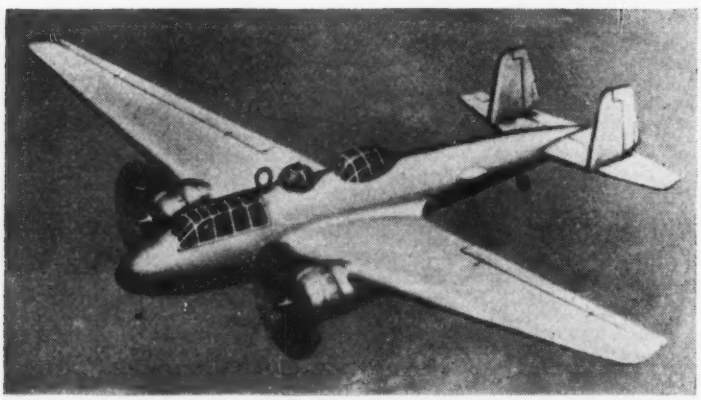
JAPANESE

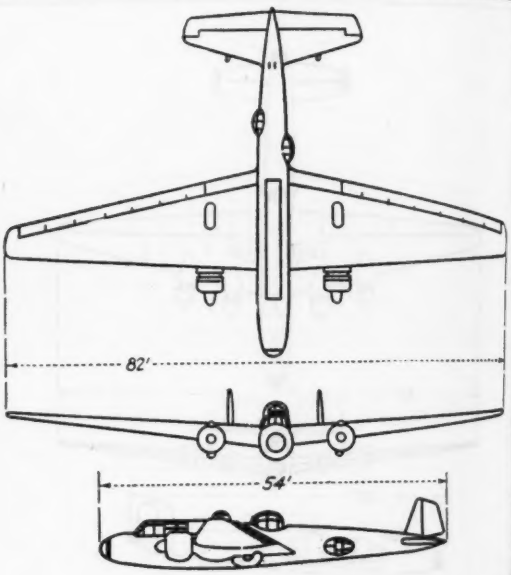




Betty 22 Navy Bomber

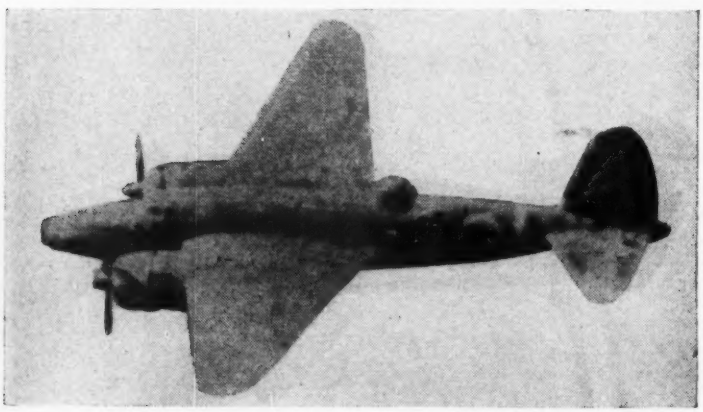
Famous torpedo-bomber has been cleaned up, given new engines, armament with power turret on top of fuselage. Powered with two Mitsubishi Kasei 1,800-hp. radials, top speed is about 330 mph., range near 2,800 miles. Armament is two 20-mm. cannon, three 7.7-mm. mgs. Two torpedoes or equal bomb load.

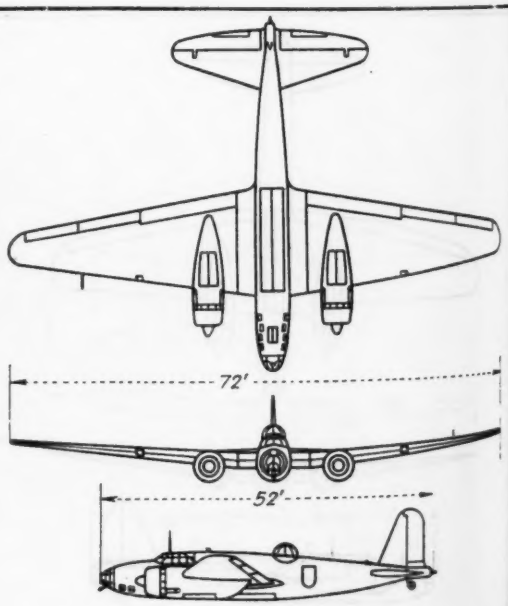




Nell 22 Navy Bomber

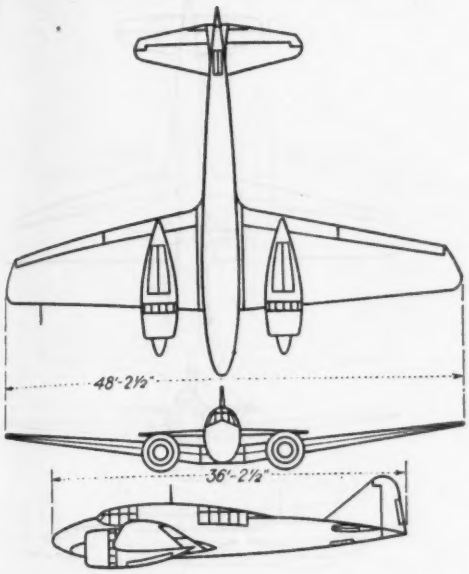
Japs have improved Nell with 1,000-hp. engines, better armament. Non-stop range is about 2,500 miles, weight empty 12,500 lbs., climb about 1,100 fpm. Credited with sinking HMS Prince of Wales and Repulse, Nells have crew of four to seven, at least four 7.7-mm. machine guns and a 20-mm. cannon.

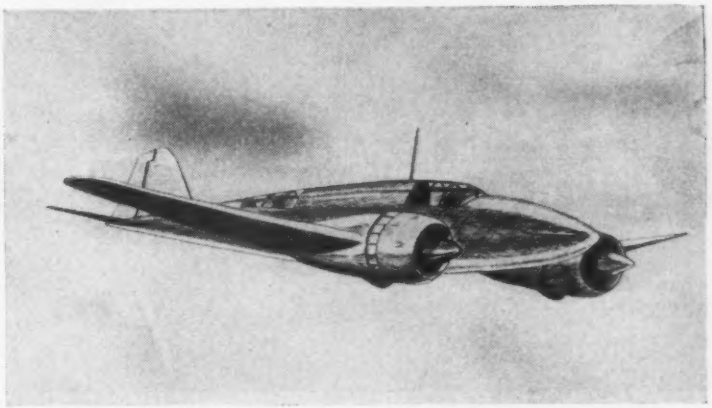




Sally 3 Army Bomber

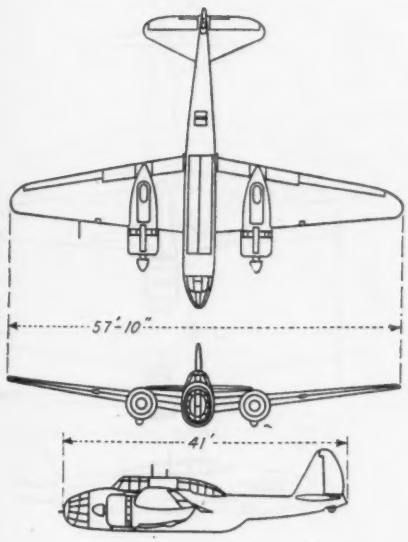
Still one of the Japs mainstays, Sally has bigger engines, hand-operated top- and tail-position turrets. Still weak in armor and fuel tank protection, it is being replaced by newer Helen. Bomb load is 4,400 lb., crew of seven, armament is 7.7-mm. and 12.7-mm. machine guns. Top speed is around 275 mph.

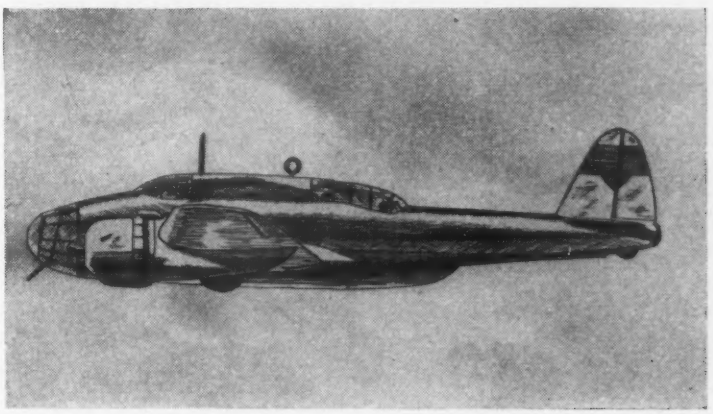




Dinah 3 Army Reconnaissance

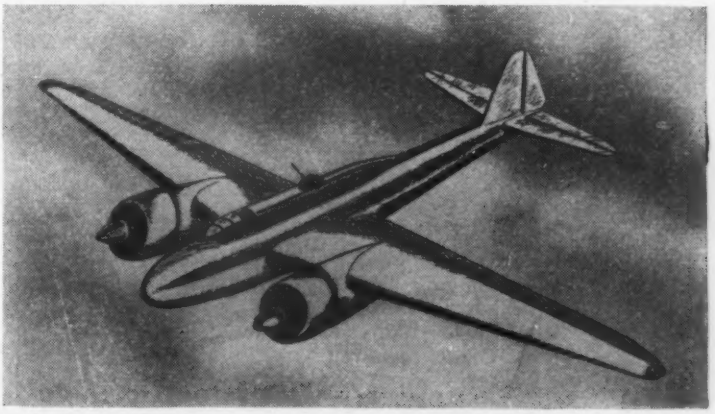
Only type used by both Jap Army and Navy, Dinah has high performance with 375 mph. top speed, climbs at 2,700 fpm., has range of 1,700 miles. Empty weight about 8,000 lb., crew two. Weak feature is armament, only one 7.7-mm. mg in rear cockpit. Engines are Mitsubishi twin-row radials of 1,000 hp.





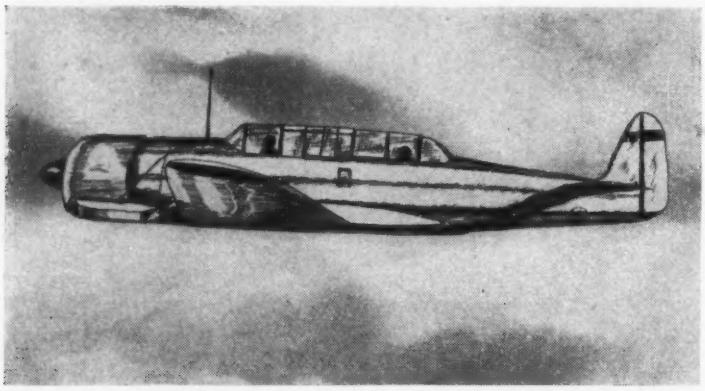
Lily 2 Army Bomber

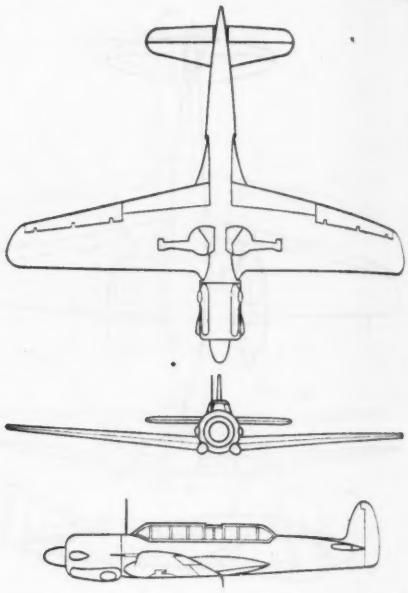
Operating mainly in CBI area where it is also used for reconnaissance, Lily resembles Martin Baltimore. Engines may be either Nakajima or Kawasaki radials; crew is three or four. Internal bomb load up to 1,500 lb. No data available as to weights or performance. Reported to be manufactured by Kawasaki.



Frances 11 Torpedo-Bomber

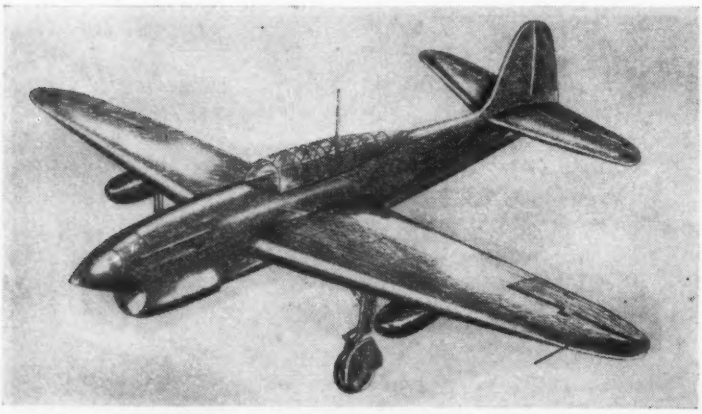
Frances reflects trend in new Jap aircraft which shows much originality. Known by Japs as Ginka (Milky Way) it is latest high performance torpedo plane in operation. "Tin Fish" are carried internally; armament is believed heavy. Construction may be all-wood smooth skin covering in contrast to usual metal.

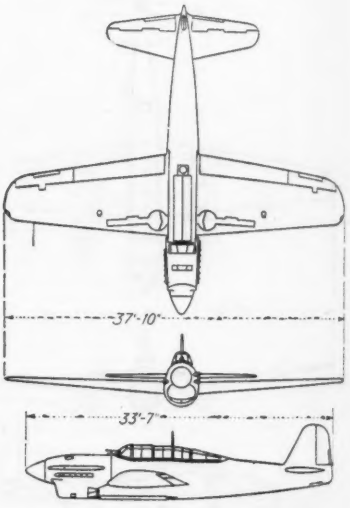




Myrt 11 Navy Reconnaissance

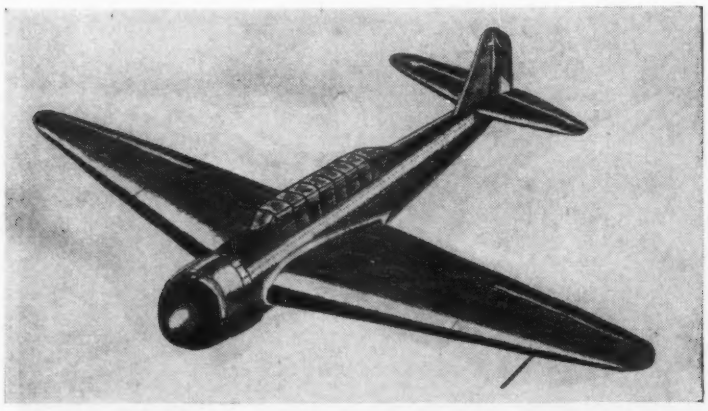
Fast and maneuverable, bearing a distinct resemblance to U. S. Vultee V-11GB, Myrt has a twin-row 18-cylinder radial and four-bladed prop. Believed to be carrier based type, with crew of 2-3, construction seems to be of very high order. The 2,000-hp. Homare engine is fitted with ejector exhausts.

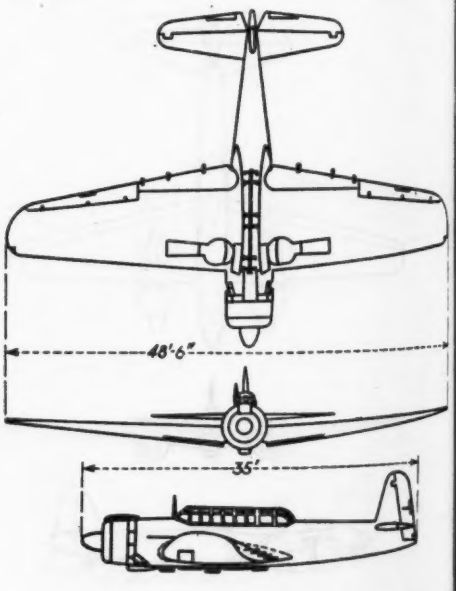




Judy 11 Navy Recc-Bomber

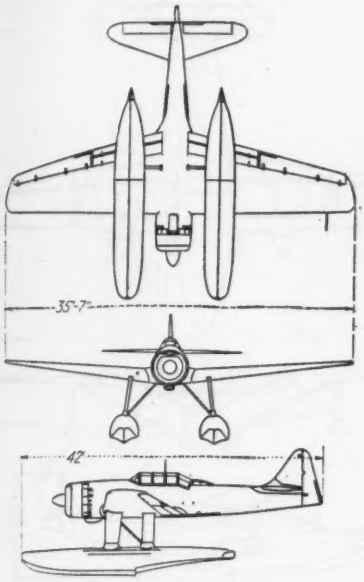
Two place all metal monoplane powered by an Aichi Atsuta in-line of 1,150-hp. this type is gradually replacing older Val. Top speed is about 325 mph., ceiling 30,700 ft. As a bomber about 750 lb. of bombs are carried in fuselage and under the wings. Armament consists only of 7.7 mm. machine guns.

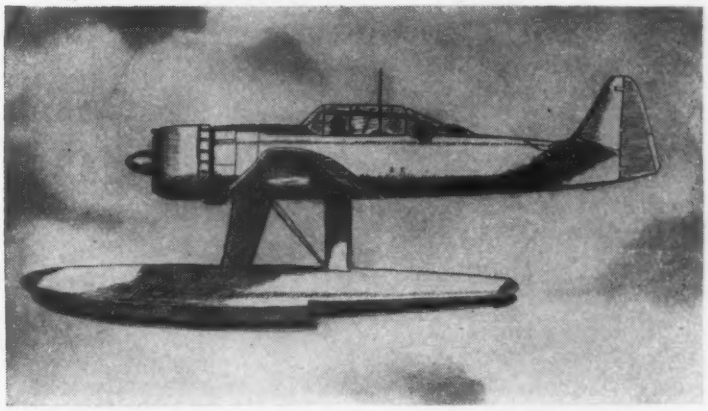




Jill 11 Torpedo-Bomber

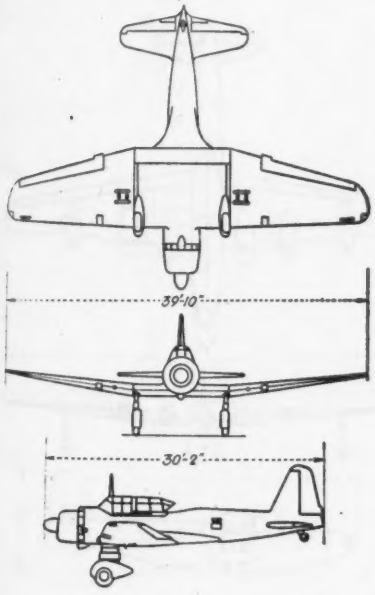
At first believed to be an improved Kate this is a new type, carries heavier load with all-round better performance. Engine is Mitsubishi Kasei twin row radial. Armament is very weak, only one 7.7-mm. mg in rear cockpit. Jill is both carrier and land-based, is believed to have four-bladed prop of late design and production.

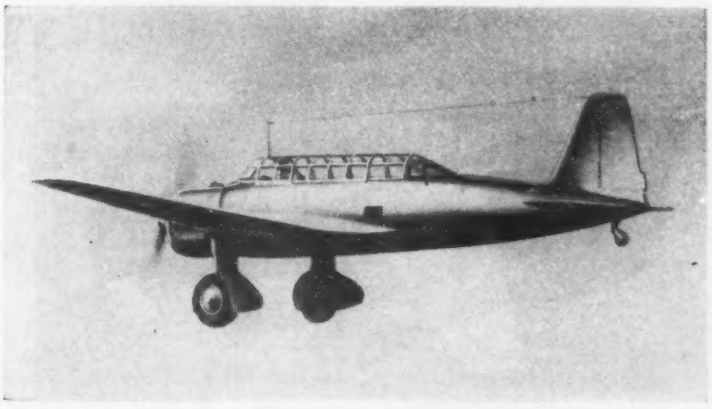




Paul 11 Navy Reconn.

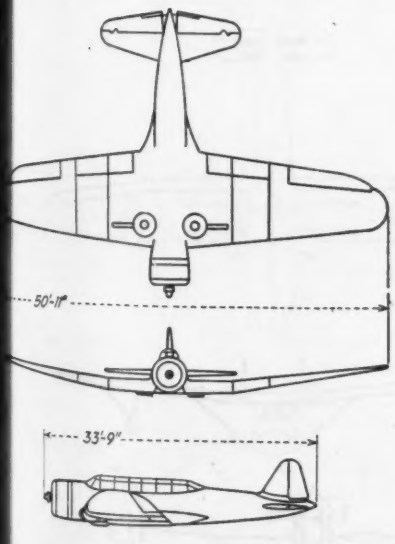
New two-place float seaplane taking Rufe's place. Twin float strut design suggests that it may also be in use as a torpedo-bomber with torpedo carried externally. The twin row engine is believed to be 14 cylinder Mitsubishi Kinsei with ejector exhaust stacks. Armament, believed to be 7.7 machine gun.





Sonia Army Reconn.

Development of Karigane civil type into scout bomber for use mainly in CBI area. Outmoded by newer Jap designs, Sonia operates in quiet areas away from opposition. Engine is Nakajima of about 900-hp. Poor performance, armament and lack of armor, self-sealing tanks make this craft very vulnerable to Allied planes.

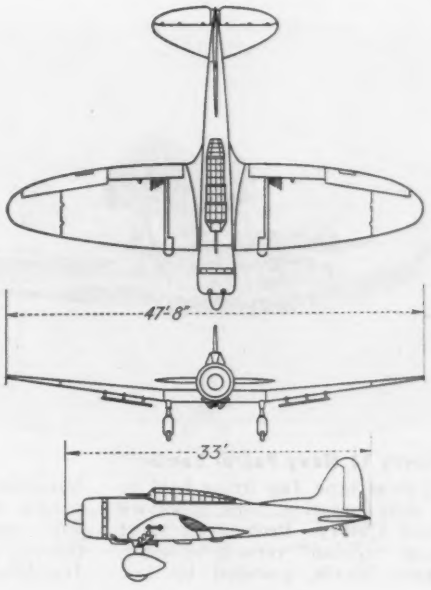


←
Kate Navy Torpedo-Bomber

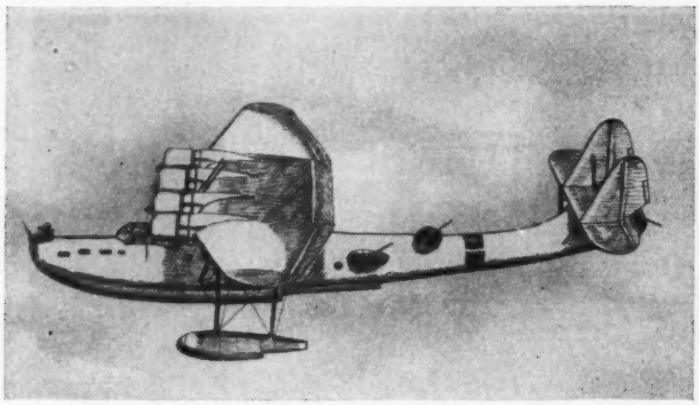
Now second line, Kates are gradually being replaced by Jill. Developed from Douglas TBD. engine is Nakajima Sakae of 1,000-hp. Range 980 mi., gross wt. about 7,200 lb., service ceiling 24,000 ft. Top speed is 230 mph. Armament is 7.7-mm. mgs. crew 2-3, armor and fuel tank protection is weak.

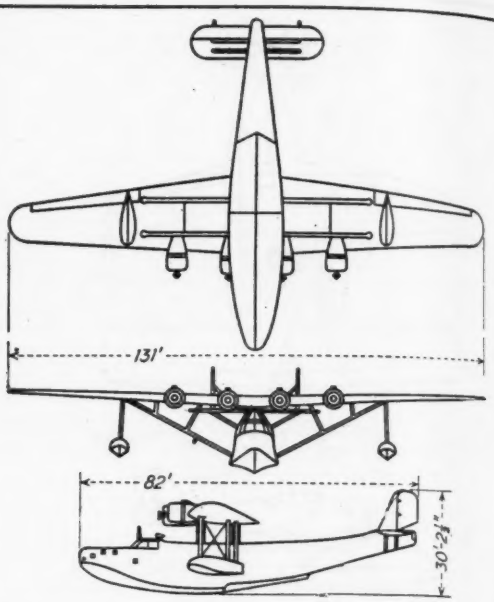
Val 22 Navy Dive Bomber →

Used by Japs in large numbers in early days of war Val is still in the fight with modifications including more powerful engine and better fairing. Mitsubishi radial of 1,075-hp. gives early model top speed of 236 mph. range 875 mi., service ceiling of 23,000 ft. Crew consists of pilot and gunner.



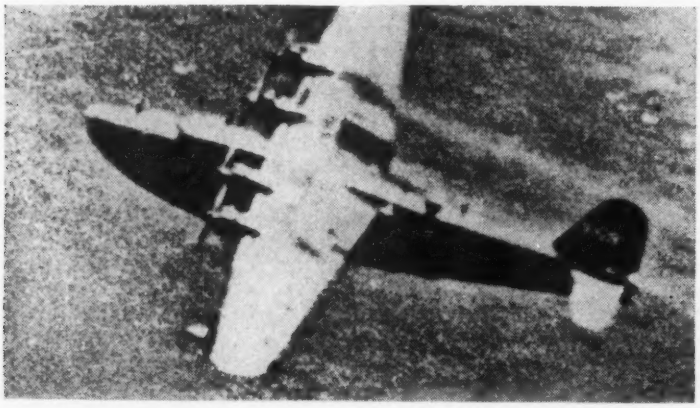
JAPANESE

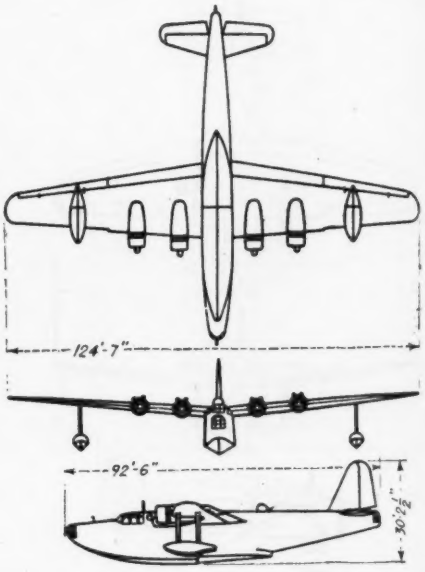




Mavis 11 Navy Patrol Bomber

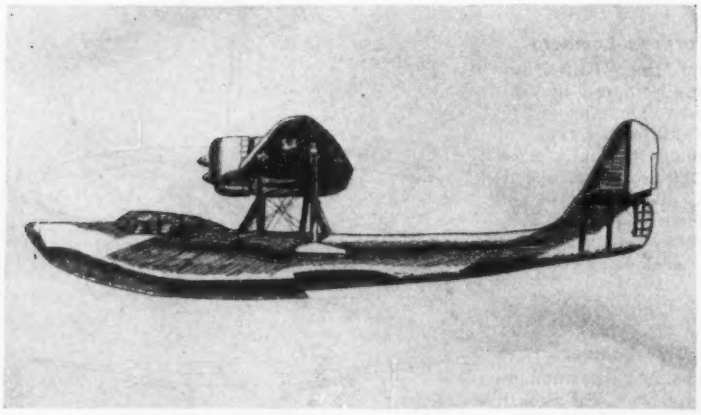
Direct copy of an early Sikorsky design powered with four Mitsubishi Kinsei at 1,000-hp. Mavis has range of about 4,000 miles. Also used as torpedo plane carrying two tin fish. Weight is 25,000 lb. empty; top speed about 220 mph. With crew of 8-11 armament is 7.7-mm. machine guns and 20-mm. cannon.

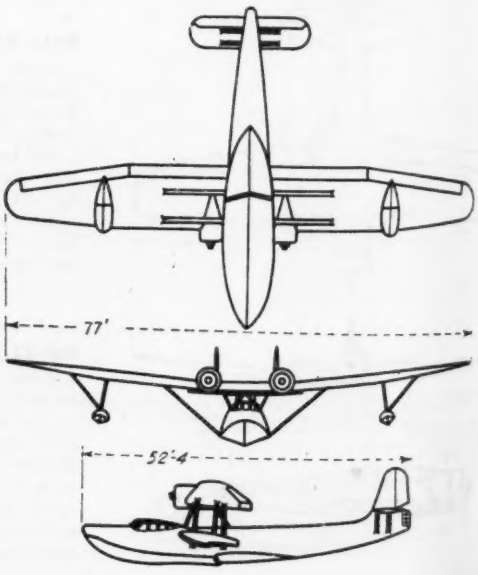




Emily 22 Navy Patrol Bomber

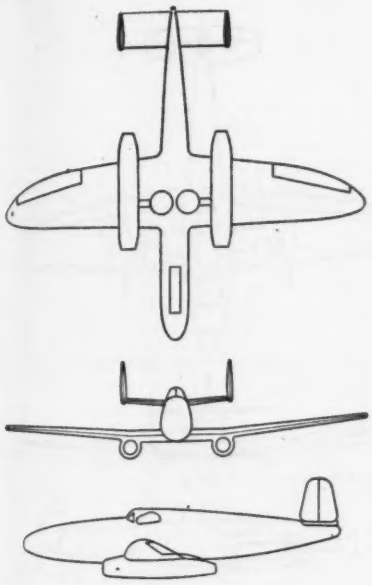
Best Jap flying boat is well armed with 7.7-, 12.7-mm. mgs. and 20-mm cannon. Range, 4,000 mi., top speed, 296 mph. Armor and self-sealing tanks have been increased but Emily is still easy meat for search Liberators. Engines are four Mitsubishi Kasei of about 1,400-hp., crew is usually of nine members.





Cherry 11 Navy Patrol Bomber

Latest type Jap flying boat to go into operation, little is known about Cherry. Probably a short range "reconn" version of older, bigger Mavis, powered by two Mitsubishi radials faired into wing's leading edge. Unbroken flap connects ailerons. Sharp pointed clipper bow is feature of Jap flying boats.



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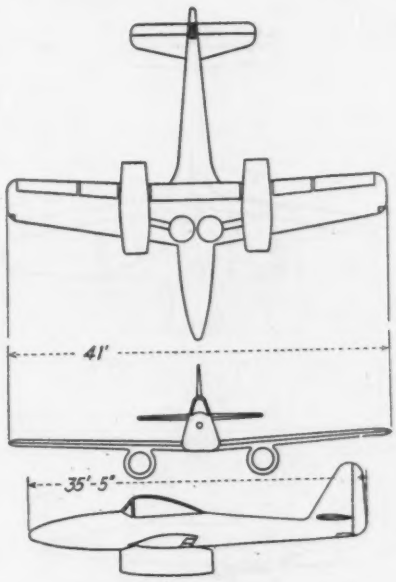
Heinkel He-280

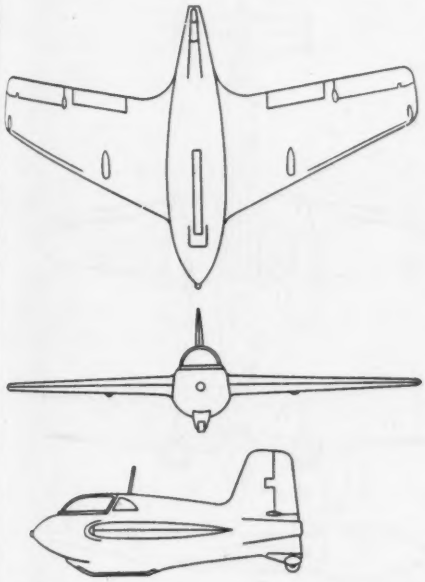
Single-place jet-propelled interceptor powered by two BMW 003 gas turbines. Although no authoritative information is available on performance, it is not believed to be as fast as the Me 262 which also has twin jet power plants.

→

Messerschmitt Me-262

Single-seat interceptor powered by two Junkers Jumo 004 gas turbine units giving high speed of over 500 mph. Armament said to consist of four 30-mm. cannon; also reported to carry two 500-lb. bombs. Some resemblance to Bell P-59A Airacomet.





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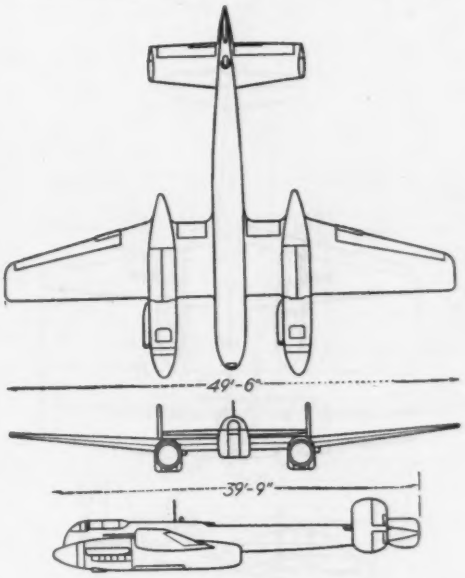
Messerschmitt Me-163B

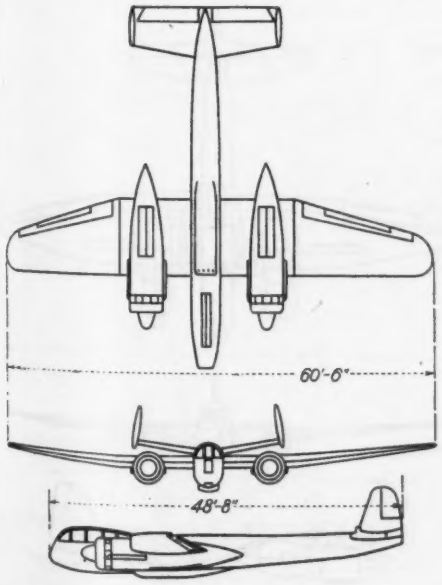
One of Nazi's latest fighters, powered by rocket propulsion unit giving total of 20 min. powered flight. This is extended, however, by shutting off power and gliding. Believed to have jettisonable wheel landing gear for take-off. Reported cannon-armed.

→

Arado Ar-240

Two-place fighter-bomber - reconnaissance craft powered by two 1,700-hp. inverted-V liquid cooled DB-603's giving top speed of between 325 and 350 mph. Carries about 2,000-lb. bomb load internally. For high altitude pressurized cabin is used.





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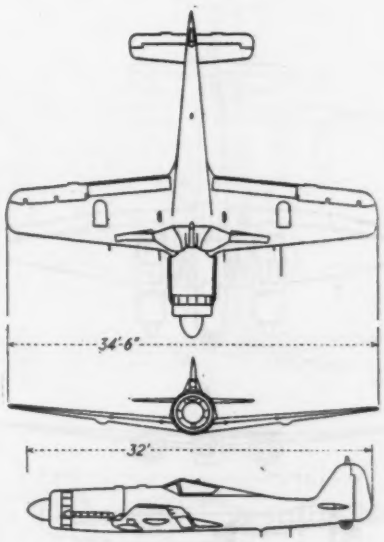
Heinkel He-219

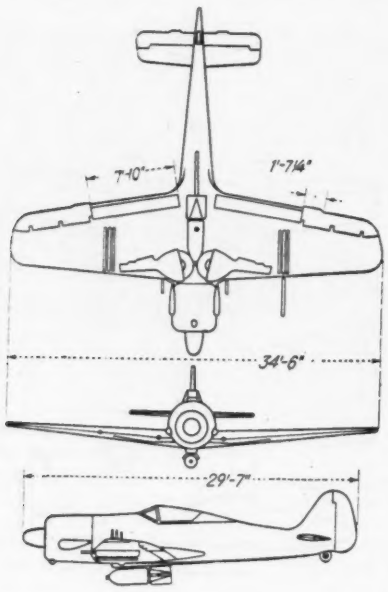
Night fighter or bomber equipped with two 1,700-hp. inverted-V DB-603's in radial cowlings or two 1,600-hp. BMW radials. Fighter has two 20-mm. cannon and four 13-mm. machine guns forward and two 7.9-mm. hand-operated rearward machine guns.

→

Focke-Wulf FW-390

FW-190 with 1,800-hp. liquid cooled V-type Daimler Benz DB-603 engine replacing the BMW air-cooled power plant. Inline engine gives high speed of about 400 mph., cruising of around 300 without boosting 80 mph. landing speed.





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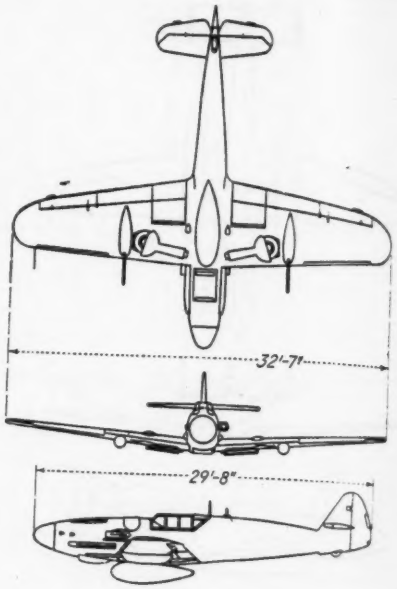
Focke-Wulf 190-A6

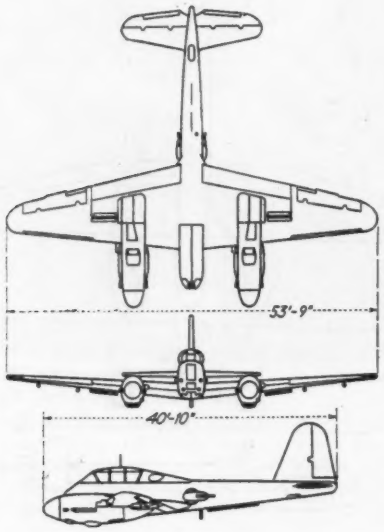
Bomber version of Luftwaffe standby — analyzed in Aviation, Oct., 1944— powered by 1,600-hp. BMW 801D aircooled engine giving high speed of 390 mph. at 20,000 ft. with service ceiling of 38,000 ft. Outer cannon and machine guns removed.

→

Messerschmitt Me-109G16

Latest in long line of Nazi workhorse fighter-bombers powered by Daimler Benz DB-605 giving 1,350-1,400 hp. at 18,500 ft. High speed 395 mph. at 22,000 ft., cruising speed, 306 mph. at 18,000 ft., service ceiling about 41,000 ft.





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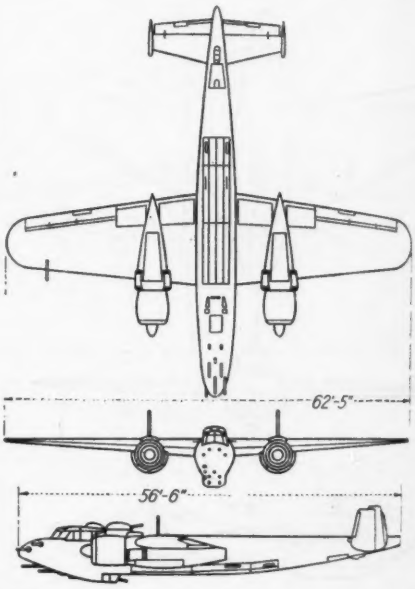
Messerschmitt Me-410

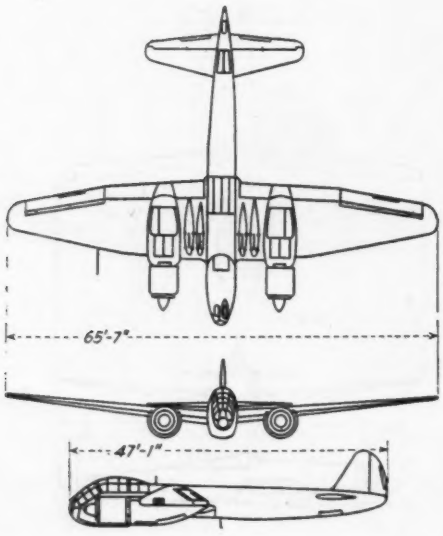
Modification of basic Me-210 fighter-bomber design, with Daimler Benz DB-603 engines delivering 1,700 hp. at 19,000 ft. replacing 1,390-hp. DB-601's. High speed, 395 mph. at 22,000 ft., gross wt. 25,350 lb., fuel capacity, 506 gal.

→

Dornier Do-217J

Development of Do-217E, having solid, pointed nose reported to mount up to 12 machine guns for night fighter work. Powered by 1,580-hp. BMW radials giving high speed of over 325 mph. Do-217N is similarly armed but has 1,460-hp. DB-603 engines.





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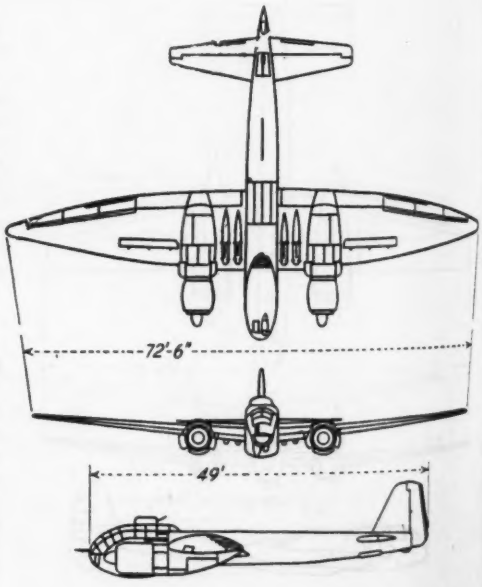
JU-88R

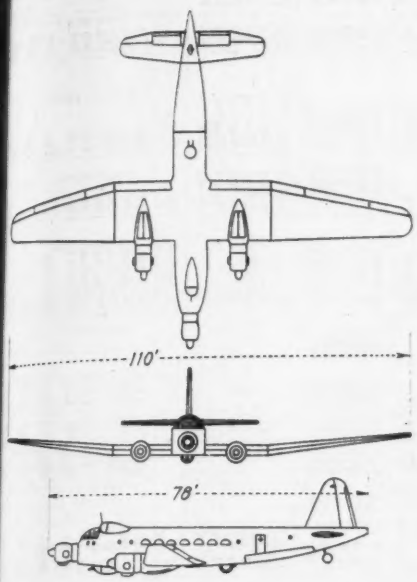
Modification of basic JU-88 design adapted for night fighting and interceptor work by installing all-glass smooth nose. Powered by two Junkers Jumo 211-F's of 1,075 hp., giving high speed of 285 mph., at 6,000 ft., service ceiling of 24,000 ft. Gross wt., 24,000 lb. Armament varies according to mission.

→

Junkers Ju-188

Appears to be enlarged version of Ju-88, with newer engines — BMW 801's or 802's of 1,600 hp. —and having pointed wingtips giving greater span. re-designed cabin and tail surfaces. High speed, 290 mph. at 20,000 ft.





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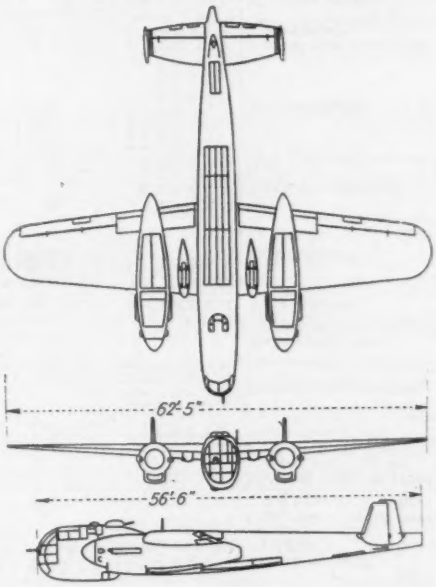
Junkers Ju-352

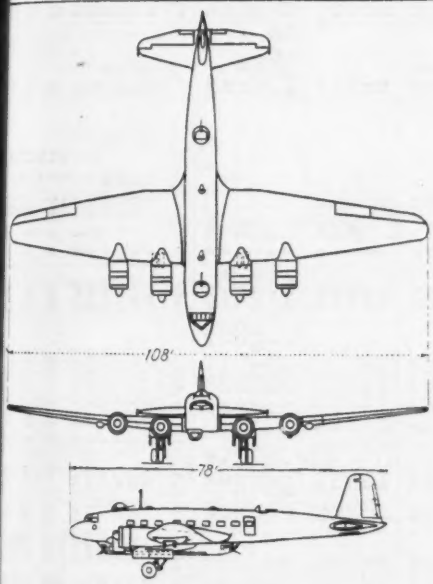
Cleaned-up version of old Ju-52, with either radial engines or 1,200-hp. inverted-V Junkers Jumo 211's. Has double wheeled landing gear; retractable loading ramp under fuselage. Reported to be of mixed wood and metal construction.

→

Dornier Do-217M

Development of Do-217K1, powered by two 1,460-hp. liquid cooled DB-603's instead of BMW radials. High speed about 315 mph., bomb load, 4,400 lb., gross wt., 35,100 lb. Armament consists of two cannon and four 7.9-mm. machine guns.





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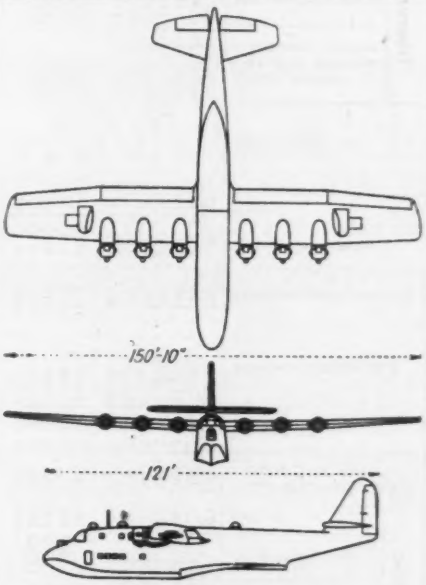
Focke-Wulf 200K

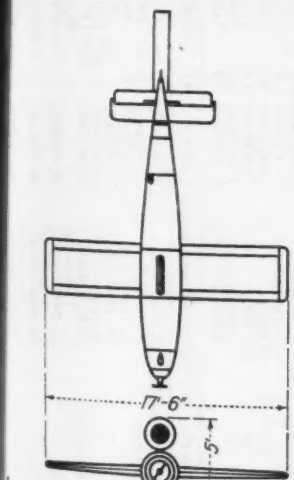
Bomber-transport powered by four 1,320-hp. BMW 801 radials. High speed, 279 mph. at 18,100 ft., cruising speed, 224 mph., climb, 850 fpm., service ceiling, 28,850 ft., fuel capacity, 2,112 gal., range, 2,300 mi.

→

Blohm & Voss BV-222

All-metal flying boat used for long range reconnaissance or as troop transport with capacity of 100. Now fitted with 1,600-hp. BMW's, has high speed of over 200 mph. at around 10,000 ft., cruising speed of about 150 mph. Gross wt., over 100,000 lb.





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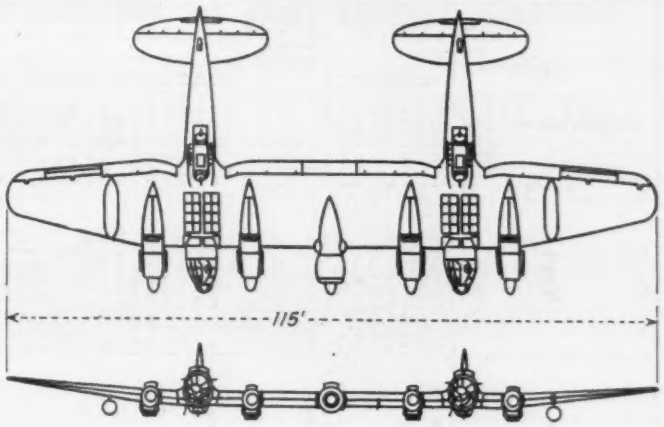
F.Z.G. 76 "Buzzbomb"

First pilotless craft to come into extensive use, a possible forerunner of new type of warfare. Pulsating jet engine of great simplicity gives high speed of about 350 mph. with 1,800-lb. explosive load. (See Aviation, Nov. 1944, p. 190)



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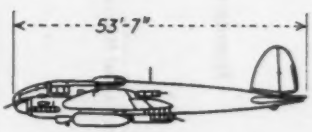
Heinkel He-111Z

Glider tug made by combining two He-111P's by adding a "Siamese" wing section which mounts a 1,580-hp. BMW, thus giving craft combination air and liquid cooled engines, since normal He-111 powerplants are 1,150-hp. DB-601's. High speed, 287 mph.



Aviation's American Engine Specifications

Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating				Total dry weight without hub or starter	Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	BMEP	Blower ratio	Dimensions			Guar. fuel cons. at cruising hp.—lb./hp.-hr.	Max. oil cons. at rated speed.—lb./hp.-hr.	Valve mechanism	Cylinder construction	Make spark plugs supplied with engine	Type ignition	Make ignition	Make of carburetor	Make of starter	Are exhaust manifolds provided?	Shipping weight crated (lb.)	C. A. A. license number
						Rated hp.	At rpm.	At altitude (ft.)	Octane								Diam. mount. ring or distance between bearers	Ht. or O.D. (in.)	Length without starter												
Air Cooled Motors Corp.	4AC-176-BA2	A	4	Hopp	D	65	2300	SL	73	182	2.8	4x3½	176	6.0	127		10⅝–12⅛	20	28⅝			Prr	Al, NI		M	Eise	Marvel		No	275	221
	4AC-199-D3	A	4	Hopp	D	85	2500	SL	73	208	2.46	4¼x3½	199	6.3	136		10⅝–12⅛	24⅜	30¹¹⁄₁₆			Prr	Al, NI		M	Eise	Marvel	Del.orAuto.	No	302	226
	4AC-199-E3	A	4	Hopp	D	90	2500	SL	80	209	2.3	4¼x3½	199	7.0	144		10⅝–12⅛	24⅜	30¹¹⁄₁₆			Prr	Al, NI		M	Eise	Marvel	Del.orAuto.	No	306	226
	6AC-298-F3	A	6	Hopp	D	130	2550	SL	80	280	2.15	4¼x3½	298	7.0	136		10⅝–18⅛	24⅜	40			Prr	Al, NI		M	Eise	Marvel	Del.orAuto.	No	350	225
	4AC-176-BA3	A	4	Hopp	D	65	2300	SL	73	202	3.3	4x3½	176	6.0	127		10⅝–12⅛	24⅜	30¹¹⁄₁₆			Prr	Al, NI		M	Eise	Marvel	Del.orAuto.	No	300	221
	6ACV-298	A	6	Vopp	D	160	3250	SL	80	298	1.86	4¼x3½	298	7.0	131		10⅝–18⅛	30½	36¼			Prr	Al, NI		M	Eise	Marvel	Delco	No	400	Pend.
	6ACV-403	A	6	Vopp	D	245	3275	SL	80	435	1.77	4⅝x4	403	7.0	147		12⅛x15⅝	33¼	43⅜			Prr	Al, NI		M	Eise	St	Delco	No	735	Pend.
Allison Div., Gen. Motors	V-1710F10	L	12	V	2:1	1325	3000	SL	100	1345	1.02	5½x6	1710	6.65	167	7.48	18⅜	36¾	85⅝			Prr			M	Scint	St		No	2150	
	V-1720R	L	12	V	2:1	1200	3000	15500	100	1352	1.13	5½x6	1710	6.65	152		18⅜	36¾	85⅞			Prr			M	Scint	St		No	2150	
	V-1710F21R	L	12	V	2:1	1325	3000	2500	100	1353	1.02	5½x6	1710	6.65	167	7.48	18⅜	36²⁷⁄₃₂	85⅞			Prr			M	Scint	St		No	2150	
	V-1710E19	L	12	V	2.23:1	1200	3000	15500	100	1435	1.20	5½x6	1710	6.65	152		18⅜	37⁹⁄₁₆	194			Prr			M	Scint	St		No	2380	
	V-3420	L	24	W		2600			100	2600	1.00	5½x6	3420	6.65	201				100	.45	0.20	Prr			M	Scint		Eclip	No		
Continental Motors Corp. (Muskegon Plant)	A-65 Series 8	A	4	Hopp	D	65	2300	SL	73	170	2.62	3⅞x3⅝	171	6.3				22⁹⁄₁₆	30²¹⁄₃₂			Prr	S	Ch26	M	Scint	St		No	348	205
	A-65 Series 9	A	4	Hopp	D	65	2300	SL	73	176	2.71	3⅞x3⅝	171	6.3				22⁹⁄₁₆	30¹¹⁄₃₂			Prr	S	Ch26	M	Scint	St		No	353	205
	A-75 Series 8	A	4	Hopp	D	75	2600	SL	73	170	2.27	3⅞x3⅝	171	6.3				22⁹⁄₁₆	30²¹⁄₃₂			Prr	S	Ch26	M	Scint	St		No	348	213
	A-75 Series 9	A	4	Hopp	D	75	2600	SL	73	176	2.35	3⅞x3⅝	171	6.3				22⁹⁄₁₆	30¹¹⁄₃₂			Prr	S	Ch26	M	Scint	St		No	353	213
	A-80 Series 8	A	4	Hopp	D	80	2700	SL	80	170	2.13	3⅞x3⅝	171	7.5				22⁹⁄₁₆	30²¹⁄₃₂			Prr	S	Ch26	M	Scint	St		No	348	217
	A-80 Series 9	A	4	Hopp	D	80	2700	SL	80	176	2.2	3⅞x3⅝	171	7.5				22⁹⁄₁₆	30¹¹⁄₃₂			Prr	S	Ch26	M	Scint	St		No	358	217
	W-670 Series 6A	A	7	Rad	D	220	2075	SL	65	485	2.12	5⅛x4⅝	668	5.4			20	42¼	34³⁄₁₆			Prr	S	Ch25	M	Scint	St		No	850	162
	W-670 Series M	A	7	Rad	D	240	2200	SL	80	485	1.98	5⅛x4⅝	668	6.1			20	42¼	34³⁄₁₆			Prr	S	Ch25	M	Scint	St		No	860	162
	W-670 Series K	A	7	Rad	D	225	2175	SL	65	485	2.07	5⅛x4⅝	668	5.4			20	42¼	34³⁄₁₆			Prr	S	Ch26	M	Scint	St		No	850	162
	C75 Series 12	A	4	Hopp	D	75	2275	SL	73	186	2.45	4¹⁄₁₆x3⅝	188	6.3				21¼	31⅝			Prr	S	Ch26	M	Scint	St	Delco	No		233
	C85 Series 12	A	4	Hopp	D	85	2600	SL	73	186	2.18	4¹⁄₁₆x3⅝	188	6.3				21¼	31⅝			Prr	S	Ch26	M	Scint	St	Delco	No		
	C115 Series 1	A	6	Hopp	D	115	2350	SL	73	262	2.27	4¹⁄₁₆x3⅝	282	6.3				24¾	41⅝			Prr	S	Ch26	M	Scint	St	Delco	No		
	C125 Series 1	A	6	Hopp	D	125	2550	SL	73	262	2.09	4¹⁄₁₆x3⅝	282	6.3				24¾	41⅝			Prr	S	Ch26	M	Scint	St	Delco	No		
	C140 Series 1	A	6	Hopp	G	140	3000	SL	73	298	2.12	4¹⁄₁₆x3⅝	282	6.3				24¾	46¾			Prr	S	Ch26	M	Scint	St	Delco	No		
(Detroit Plant)	R975-32	A	9	Rad	D	450	2300	SL	87	710	1.58	5x5½	972	6.3	159	8.307	23⅛	45⅜	41.80		.025	Prr	S	Ch	M	Br	Hol	Eclip	Yes		
	GR9-A	A	9	Rad	G	500	2500	5000	87	745	1.49	5x5½	972	6.3	171	8.86	23⅛	45⅜	43.32		.025	Prr	S	Ch	M	Br	St	Eclip	No		
Guiberson Diesel Engine Co.	A-1020	A	9	Rad	D	310	2200	SL	50	653	2.1	5⅛x5½	1021	14	110		20	47⅛	33⅜	.370	.021	Prr	AIS					Br	No		220
Jacobs Aircraft Engine Co.	L-4MB(R755A1)	A	7	Rad	D	225	2000	SL	73	505	2.2	4¼x5	757	5.4	118		16.5	44	40⁷⁄₃₂	.530	.018	Prr	S		M	Scint	St	Eclip	No		121
	L-4M(R-755A3)	A	7	Rad	D	225	2000	SL	73	507	2.2	4¼x5	757	5.4	118		16.5	44	40⁷⁄₃₂	.530	.018	Prr	S		M	Scint	St	Eclip	No		121
	L-4MA7	A	7	Rad	D	225	2000	SL	73	510	2.3	4¼x5	757	5.4	118		16.5	44	41⅞	.530	.018	Prr	S		M	Scint	St	Eclip	No		121
	L-6MB(R-915A)	A	7	Rad	D	300	2100	SL	80	555	1.8	5½x5½	914	6	124		16.5	45⅜	40¹³⁄₁₆	.535	.025	Prr	S		M	Scint	St	Eclip	No		195
	L-6M(R-915A3)	A	7	Rad	D	300	2100	SL	80	557	1.9	5½x5½	914	6	124		16.5	45⅜	40¹³⁄₁₆	.535	.025	Prr	S		M	Scint	St	Eclip	No		195
	L-6MBA(R-915A4)	A	7	Rad	D	300	2100	SL	80	558	1.9	5½x5½	914	6	124		16.5	45⅜	41¹¹⁄₁₆	.535	.025	Prr	S		M	Scint	St	Eclip	No		195
	L-6MA	A	7	Rad	D	300	2100	SL	80	560	1.9	5½x5½	914	6	124		16.5	45⅜	41¹¹⁄₁₆	.535	.025	Prr	S		M	Scint	St	Eclip	No		195
Kinner Motors, Inc.	K-5	A	5	Rad	D	100	1810	SL	73	304	3.04	4¼x5¼	372	5.1	118		14	45⅜	33.0	.55	.025	Prr	AIS	BG	M	Scint	StHol	Eclip	Op	600	3
	B-5&B-54	A	5	Rad	D	125	1925	SL	73	312	2.50	4⅝x5¼	441	5.25	117		14	45⅜	33.0	.55	.025	Prr	AIS	BG	M	Scint	StHol	Eclip	Op	600	51
	R-5 Series 2	A	5	Rad	D	160	1850	SL	73	335	2.10	5x5½	540	5.50	127		14	45⅜	33.1	.55	.025	Prr	AIS	BG	M	Scint	StHol	Eclip	Op	600	153
	R-55	A	5	Rad	D	160	1850	SL	73	345	2.15	5x5½	540	5.50	127		14	45⅜	33⅜	.55	.025	Prr	AIS	BG	M	Scint	StHol	Eclip	Op	600	153
	R-56	A	5	Rad	D	160	1850	SL	73	362	2.26	5x5½	540	5.50	127		14	45⅜	33⅜	.55	.025	Prr	AIS	BG	M	Scint	StHol	Eclip	Op	600	153
Lycoming Div., Aviation Corp.	O-145-BZ	A	4	Hopp	D	65	2550	SL	73	163.4	....	3.625x3.5	144.49	6.5			8.5–10.25	20.59	24.62			Prr			M		Scint	Marvel	No	206.4	210
	GO-145-C2	A	4	Hopp	27:17	75	3200	SL	73	196.39	....	3.625x3.5	144.49	6.5			8.5–10.25	20.59	29.31			Prr			M		Scint	Marvel	No	247.27	210
	O-235	A	4	Hopp	D	100	2550	SL	73	234.6	....	4.37x3.875	233.30	6.25			11.50	25.02	33.25			Prr			M		Scint	Marvel	No	287.63	223
	O-290	A	4	Hopp	D	125	2450	SL	73	243.6	....	4.875x3.875	289	6.25			11.50	25.49	29.93			Prr			M		Scint	Marvel	No	296.63	229
	O-350	A	6	Hopp	D	150	2500	SL	73	340.9	....	4.875x3.875	349.50	6.25			14	26.26	39.94			Prr			M		Scint	Marvel	No	394.7	227
	O-435	A	6	Hopp	D	175	2300	SL	73	346.48	....	4.875x3.875	434	6.25			14	26.36	39.94			Prr			M		Scint	Marvel	No	402.99	228
Packard Motor Car Co.	Rolls-Royce 1650-7	L	12	V	G	1490	3000	SL	100	1690	1.13	5.4x6	1649	6		7.35		40.86	87.1			Prr	AIS		M	Delco	St	Eclip			
Pratt & Whitney Division, United Aircraft Corp.	R-985-T1B3	A	9	Rad	D	450	2300	SL	91	674	1.50	5³¹⁄₁₆x5³¹⁄₁₆	985	6	157	10	23⅜	46.13	43.06		.025	Prr	AIS		M	Scint	St	Op	No		123
	R-985-SB3	A	9	Rad	D	450	2300	3500	91	682	1.70	5³¹⁄₁₆x5³¹⁄₁₆	985	6	157	10	23⅜	46.13	43.06		.025	Prr	AIS		M	Scint	St	Op	No		123
	R-1340-S3H1	A	9	Rad	D	600	2250	3000	91	865	1.57	5¾x5¾	1344	6	157	10	23⅜	51.81	43.0		.025	Prr	AIS		M	Scint	St	Op	No		143
	R-1340-S3H1-G	A	9	Rad	3:2	600	2250	3000	91	938	1.70	5¾x5¾	1344	6	157	10	23⅜	51.81	47.81		.025	Prr	AIS		M	Scint	St	Op	No		142
	R-1830-S1C3-G	A	14	Rad	16:9	1200	2700	4900	91	1467	1.40	5½x5½	1830	6.7	192	7.15	27	48.19	61.16		.025	Prr	AIS		M	Scint	St	Op	No		186
	R-1830-S3C4-G	A	14	Rad	16:9	1200	2700	4900	100	1492	1.36	5½x5½	1830	6.7	192	7.15	27	48.19	63.44		.025	Prr	AIS		M	Scint	St	Op	No		186
	Two speed					1050	2700	13100							168	8.47															
	R-2000-2SD-G	A	14	Rad	2:1	1350	2700	2000	100	1570	1.43	5¾x5½	2000	6.5	197	7.15	27	49.50	59.63		.025	Prr	AIS		M	Scint		Op	No		230
	Two speed															8.47														
	R-2000-2SD12-G	A	14	Rad	2:1	1450	2800	1500	100	1590	1.33	5¾x5½	2000	6.5	205	7.15	27	49.50	61.02		.025	Prr	AIS		M			Op	No		
	Two speed					1150	2700	16000							162	9.52															
	R-2000-2SD13-G	A	14	Rad	2:1	2000	2700	1000	100	2200	1.43	5¾x5½	2804	6.65	219	7.50	30	52.50	75.22		.025	Prr	AIS		M		St	Op	No		231

Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: At rpm.	Rating: At altitude (ft.)	Octane	Total dry weight without hub or starter	Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	BMEP	Blower ratio	Dimensions: Diam. mount. ring or distance between bearers	Dimensions: Ht. or O.D. (in.)	Dimensions: Length without starter	Guar. fuel cons. at rating hp.—lb./hp./hr.	Max. oil cons. at rated speed.—lb./hp./hr.	Valve mechanism	Cylinder construction	Make spark plug supplied with engine	Type ignition	Make ignition	Make of carburetor	Make of starter	Are exhaust manifolds provided?	Shipping weight crated (lb.)	C. A. A. license number
Pratt & Whitney Division, United Aircraft Corp.—*Continued.*	R-2800-SSB2-G	A	18	Rad	2:1	2000	2700	1000	100	2480	1.48	5¾x6	2804	6.65	210	7.8ms	30	52.50	88.47	....	.025	Prr	AIS	.....	M	Scint	St	Op	No	.....	.....
	Two stage				16:9	1800	2700	15500	...	2460					189	6.46al														
	Two speed					1650	2700	22500							173	7.93ah														
	R-2800-TSB1-G	A	18	Rad	2:1	2000	2700	1500	100	2260	1.39	5¾x6	2804	6.65	210	7.60	30	52.50	75.72	....	.025	Prr	AIS	.....	M	Scint	St	Op	No	.....	231
Ranger Aircraft Engines Div., Fairchild Engine & Aircraft Corp.	6-440C-5	A	6	Lid	D	200	2450	SL	87	386	1.93	4¼x5½	441	7.5	146	.....	17⅞	33½	53$^{5}/_{32}$	.44	.025	Uhc	S	BG	M	Scint	Marvel	.....	No	.....	216
	SGV-770C-1B	A	12	Vid	3:2	450	3000	12000	91	760	1.68	4x5⅛	773	6.5	154	9.5	13⅜	34⅛	66$^{61}/_{64}$	.49	.025	Uhc	S	AC	M	Scint	St	.....	No	.....	.....
	SGV-770D-5	A	12	Vid	2.37:1	700	3600	SL	100	870	.....	.....	.....	.....	.....	.....	.....	.....	74.92	.....	.....	.....	.....	.....	M	.....	.....	.....	.....	.....	.....
Warner Aircraft Corp.	Scarab	A	7	Rad	D	125	2050	SL	73	285	2.28	4¼x4¼	422	5.2	115	.....	17	36$^{9}/_{16}$	29	....	.025	Prr	S	Ch	M	Scint	St	.....	No	510	2
	Super Scarab	A	7	Rad	D	145	2050	SL	73	305	2.1	4⅝x4¼	499	5.3	115	.....	17	36$^{9}/_{16}$	29¾	....	.025	Prr	S	Ch	M	Scint	Hol	.....	No	585	104
	Super Scarab	A	7	Rad	D	165	2100	SL	73	332	2.01	4⅝x4¼	499	6.4	123	.....	17½	37¼	30$^{25}/_{64}$	....	.025	Prr	S	Ch	M	Scint	St	.....	No	595	214
	R550-1	A	7	Rad	D	180	2100	SL	73	371	2.06	4⅞x4¼	550	6.2	123	.....	17½	37¼	29$^{31}/_{16}$	....	.025	Prr	S	Ch	M	Scint	Hol	.....	No	614	.....
Commonwealth Aircraft, Inc.	Ken-Royce 5G	A	5	Rad	D	90	2250	SL	73	226	2.51	4¼x4¾	266	6.1	...	.....	15¼, 17⅞	33¼	23¾	.54	....	Prr	S	Ch	M	Scint	Hol	Eclip	No	.....	46
	Ken-Royce 7G	A	7	Rad	D	120	2225	SL	73	285	2.38	4¼x4¾	372	6.1	...	.....	15¼, 19$^{11}/_{16}$	33¼	24$^{7}/_{16}$	.54	....	Prr	S	BG	M	Scint	Hol	or Ch	No	.....	52
White Aeronautical Corp.	R-160	A	3	Rad	D	52	2325	.....	73	138	....	4⅛x4	160	5	...	.....	13	36	24	.55	....	Prr	AIS	.....	M	Ed-Split	St	.....	No	.....	203
	R-167	A	3	Rad	D	65	2350	.....	73	140	....	4⅛x4	167	5.8	...	.....	13	36	24	.55	....	Prr	AIS	.....	M	Ed-Split	St	.....	No	.....	203
	R-177	A	3	Rad	D	75	2450	.....	73	142	....	4¼x4	177	5.8	...	.....	13	36	24	.55	....	Prr	AIS	.....	M	Ed-Split	St	.....	No	.....	215
	R-275	A	5	Rad	D	95	2200	.....	73	192	....	4⅛x4	275	5.1	...	.....	13	36	24	.55	....	Prr	AIS	.....	M	Ed-Split	St	.....	No	.....	212
Wright Aeronautical Corp.	R-760-ET	A	7	Rad	D	235	2000	SL	73	540	2.3	5x5½	756	6.1	110	.....	20	45	42.44	.480	.025	Prr	AIS	Op	M	Scint	St	Op	Yes	1080	126
	R-760-E1	A	7	Rad	D	300	2250	SL	73	570	1.9	5x5½	756	6.1	118	7.05	20	45	42.44	.470	.025	Prr	AIS	Op	M	Scint	St	Op	Yes	1050	94
	R-760-E2	A	7	Rad	D	350	2400	SL	91	570	1.63	5x5½	756	6.3	118	9.17	20	45	42.44	.485	.025	Prr	AIS	Op	M	Scint	St	Op	Yes	1080	155
	R-975-E1	A	9	Rad	D	365	2100	SL	73	660	1.81	5x5½	973	6.1	121	7.8	20	45	42.44	.470	.025	Prr	AIS	Op	M	Scint	St	Op	Yes	1190	87
	R-975-E3	A	9	Rad	D	450	2250	SL	91	675	1.5	5x5½	973	6.3	132	10.15	20	45	41.2	.46	.025	Prr	AIS	Op	M	Scint	St	Op	Yes	1215	125
	R-1820-F52	A	9	Rad	D	890	2200	SL	91	1000	1.12	6⅛x6⅞	1823	6.4	126	7.0	24	54.12	43.38	.44	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1750	148
	GR-1820-F52	A	9	Rad	G	875	2200	SL	91	1095	1.25	6⅛x6⅞	1823	6.4	126	7.0	24	54.12	47.81	.45	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	148
	R-1820-F53	A	9	Rad	D	785	2200	SL	91	1000	1.27	6⅛x6⅞	1823	6.4	126	8.31	24	54.12	43.38	.47	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1750	149
	GR-1820-F53	A	9	Rad	G	770	2200	SL	91	1095	1.42	6⅛x6⅞	1823	6.4	126	8.31	24	54.12	47.81	.48	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	149
	R-1820-F55	A	9	Rad	D	875	2200	SL	91	1012	1.16	6⅛x6⅞	1823	6.4	126	7.14&10	24	54.12	43.38	.45	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1750	198
	GR-1820-F55	A	9	Rad	G	875	2200	SL	91	1107	1.26	6⅛x6⅞	1823	6.4	126	7.14&10	24	54.12	47.81	.45	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	198
	R-1820-F56	A	9	Rad	D	785	2200	SL	91	1000	1.27	6⅛x6⅞	1823	6.4	126	8.83	24	54.12	43.38	.485	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1750	159
	GR-1820-F56	A	9	Rad	G	770	2200	SL	91	1095	1.42	6⅛x6⅞	1823	6.4	126	8.83	24	54.12	47.81	.495	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	159
	R-1820-F62	A	9	Rad	D	900	2350	SL	91	1000	1.11	6⅛x6⅞	1823	6.4	126	7.0	24	54.12	43.38	.450	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1750	148
	GR-1820-F62	A	9	Rad	G	900	2350	SL	91	1095	1.22	6⅛x6⅞	1823	6.4	126	7.0&10	24	54.12	47.81	.450	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	148
	R-1820-F65	A	9	Rad	D	900	2350	SL	91	1012	1.12	6⅛x6⅞	1823	6.4	126	7.14&10	24	54.12	43.38	.450	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1750	198
	GR-1820-F65	A	9	Rad	G	900	2350	SL	91	1107	1.23	6⅛x6⅞	1823	6.4	126	7.14&10	24	54.12	47.81	.450	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	198
	R-1820-G2	A	9	Rad	D	1000	2200	SL	91	1103	1.1	6⅛x6⅞	1823	6.45	137	7.0	24	54¼	43¾	.44	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	157
	GR-1820-G2	A	9	Rad	G	1000	2200	SL	91	1198	1.2	6⅛x6⅞	1823	6.45	137	7.0	24	54¼	47¾	.44	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1950	157
	R-1820-G3	A	9	Rad	D	875	2200	SL	91	1103	1.26	6⅛x6⅞	1823	6.45	137	8.31	24	54¼	43¾	.475	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	171
	GR-1820-G3	A	9	Rad	G	875	2200	SL	91	1198	1.37	6⅛x6⅞	1823	6.45	137	8.31	24	54¼	47¾	.475	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1950	171
	R-1820-G3B	A	9	Rad	D	900	2350	SL	91	1103	1.23	6⅛x6⅞	1823	6.2	137	8.31	24	54¼	43¾	.480	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	171
	GR-1820-G3B	A	9	Rad	G	900	2350	SL	91	1198	1.33	6⅛x6⅞	1823	6.2	137	8.31	24	54¼	47¾	.480	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1950	171
	R-1820-G5	A	9	Rad	D	1000	2200	SL	91	1115	1.11	6⅛x6⅞	1823	6.45	137	7.14&10	24	54¼	43¾	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	154
	GR-1820-G5	A	9	Rad	G	1000	2200	SL	91	1210	1.21	6⅛x6⅞	1823	6.45	137	7.14&10	24	54¼	47¾	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1950	154
	R-1820-G5E	A	9	Rad	D	1000	2200	SL	91	1139	1.14	6⅛x6⅞	1823	6.45	137	7.14&10	24	54¼	43¾	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1850	154
	GR-1820-G5E	A	9	Rad	G	1000	2200	SL	91	1234	1.23	6⅛x6⅞	1823	6.45	137	7.14&10	24	54¼	47¾	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	1950	154
	GR-1820-G102A	A	9	Rad	G	1100	2350	SL	91	1275	1.16	6⅛x6⅞	1823	6.3	143	7.0	24	55.1	48.12	.450	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2040	169
	GR-1820-G103A	A	9	Rad	G	1000	2350	SL	91	1275	1.27	6⅛x6⅞	1823	6.3	143	8.31	24	55.1	48.12	.480	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2040	180
	GR-1820-G105A	A	9	Rad	G	1100	2350	SL	91	1287	1.17	6⅛x6⅞	1823	6.3	143	7.14&10	24	55.1	48.12	.460	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2055	192
	718-C9-GB1	A	9	Rad	G	1100	2350	SL	91	1287	1.17	6⅛x6⅞	1823	6.3	143	7.134&10.04	24	55.1	48.12	.465	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2057	192
	702-C9-GC	A	9	Rad	G	1200	2500	SL	91	1310	1.09	6⅛x6⅞	1823	6.7	152	7.0	24.5	55⅛	50.04	.465	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2057	219
	GR-1820-G203A	A	9	Rad	G	1100	2500	SL	91	1310	1.19	6⅛x6⅞	1823	6.7	141	8.3	24.5	55⅛	50.04	.490	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2090	.....
	704-C9-GC	A	9	Rad	G	1200	2500	SL	91	1320	1.10	6⅛x6⅞	1823	6.7	152	7.14&10	24.5	55⅛	50.04	.465	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2067	219
	728-C9-GC	A	9	Rad	G	1200	2500	SL	91	1310	1.09	6⅛x6⅞	1823	6.3	152	7.0	24.5	55⅛	50.04	.465	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2055	219
	730-C9-GD	A	9	Rad	G	1200	2500	SL	91	1310	1.09	6⅛x6⅞	1823	6.2	152	7.0	24.5	55⅛	50.04	.480	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2090	219
	579-G14-AC1	A	14	Rad	G	1600	2400	SL	100	1935	1.21	6¼x6$^{5}/_{16}$	2603	6.85	144	7.0	27	55	62.06	.450	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2910	176
	GR-2600-A2B	A	14	Rad	G	1600	2400	SL	91	1935	1.21	6¼x6$^{5}/_{16}$	2603	6.3	144	7.0	27	55	62.06	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2910	176
	GR-2600-A5A	A	14	Rad	G	1600	2400	SL	100	1950	1.22	6¼x6$^{5}/_{16}$	2603	6.85	144	7.14&10	27	55	62.06	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2925	.....
	GR-2600-A5B	A	14	Rad	G	1600	2400	SL	91	1950	1.22	6¼x6$^{5}/_{16}$	2603	6.3	144	7.14&10	27	55	62.06	.440	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2925	.....
	585-C14-BA	A	14	Rad	G	1700	2500	SL	100	1965	1.15	6¼x6$^{5}/_{16}$	2603	6.9	152	7.3	28	54¼	62.06	.460	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2925	176
	586-C14-BA	A	14	Rad	G	1700	2500	SL	100	1980	1.16	6¼x6$^{5}/_{16}$	2603	6.85	152	7.06&10.02	28	54¼	62.06	.460	.025	Prr	AIS	Op	M	Scint	StHol	Op	No	2925	176
	C9GR1820	A	9	Rad	G	1350	2700	SL	100	1315	.97	6⅛x6⅞	1823	6.55	154	7.0	24.5	55⅛	47.29	.460	.025	Prr	AIS	Op	M	Ed-Split	St	Op	No	.....	.....
	C9GR1820	A	9	Rad	G	1350	2700	SL	100	1333	.99	6⅛x6⅞	1823	6.55	154	7.13&10.04	24.5	55⅛	47.29	.460	.025	Prr	AIS	Op	M	Ed-Split	St	Op	No	.....	.....
	C14GR2600	A	14	Rad	G	1900	2800	SL	100	2045	1.07	6¼x6$^{5}/_{16}$	2603	6.90	152	7.06&10.06	28	54.08	66.08	.460	.025	Prr	AIS	Op	M	Bosch	St	Op	No	.....	.....
	C18GR3350	A	18	Rad	G	2200	2800	SL	100	2646	1.20	6¼x6$^{5}/_{16}$	3347	6.85	146	6.06	38	55¾	76.26	.460	.025	Prr	AIS	Op	M	Scint	Ceco	Op	No	.....	.....
	C18GR3350	A	18	Rad	G	2200	2800	SL	100	2670	1.21	6¼x6$^{5}/_{16}$	3347	6.85	146	6.61&8.81	38	55¾	76.26	.460	.025	Prr	AIS	Op	M	Scint	Ceco	Op	No	.....	.....

A —Aircooled
Al—Aluminum alloy
B —Battery
Ch. —Champion
D —Direct
Eclip.—Eclipse
Ed.Split—Edison Splitdorf
Eise. —Eisemann
G —Geared
Hol —Holley
Hopp—Horizontal opposed
L —Liquid Cooled
Lid—Inline inverted
M —Magneto
NI —Nickel Iron
Prr —Push rod-rocker
Rad—Radila
S —Steel
Scint—Scintilla
SL —Sea level
St —Stromberg
ms —main stage
al —aux. low
ah —aux. high

Aviation's Foreign Aircraft Engine Specifications

Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: At r.p.m.	Rating: At altitude (ft.)	Rating: Octane fuel	Weights: Total dry without hub or starter	Weights: Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	B.M.E.P.	Blower ratio	Dimensions: Ht. or O. D. (in.)	Dimensions: Length without starter	Fuel consumption at 9 max. cruising hp. per hp. per hr. (lb.)	Max. oil consumption at rated speed	Valve mechanism	Cylinder construction	Type ignition	Make ignition	Make of carburetors	Make of starter
BRITISH																										
Alvis, Ltd	Pelides	A	14	S. Rad	G	1060	2150	S. L.	87	1475	1.43	5.75x6.5	2360	6.1	160	7.125:1	52	67	.....	....	prr	N. S.	M	.....	Z	.....
	Pelides Major	A	14	S. Rad	G	1010	2300	S. L.	87	1475	...	5.75x6.5	2360	6.1	145	8.826:1	52	67	.....	....	prr	N. S.	M	.....	Z	.....
	Leonides	A	9	Rad	G	450	3000	S. L.	87	708	1.70	4.80x4.41	718.5	6.3	152	6.5:1	41.5	52	.....	....	prr	N. S.	M	.....	Z	.....
Armstrong Siddeley Motors, Ltd.	Cheetah XI	A	7	Rad	G	415	2650	7500	87	750	1.80	5.00x5.25	759	6.35	163	6.25:1	43.3	52.7	.....	....	prr	Hi.	M	.....	C. H.	.....
	Cheetah XV	A	7	Rad	G	420	....	S. L.	87	805	1.20	5.25x5.50	835	6.35	155	.....	47.7	50	.58	.018	prr	.....	M	BTH	Hobson	Rotax
	Panther X	A	14	Rad	G	700	2250	3000	87	1070	1.53	5.25x5.5	1667	6.35	147	5.88:1	47 7	59	.....	....	prr	AL.	M	.....	C. H.	.....
	Tiger IXC	A	14	Rad	G	805	2375	6500	87	1260	1.62	5.5 x6	1996.4	6.25	129	4.5:1	50.8	68.3	.....	....	prr	S.-AL.	M	.....	C. H.	.....
Bristol Aeroplane Co., Ltd.	Mercury XII	A	9	Rad	G	820	2400	3500	87	1010	1.22	5.75x6.5	1520	6.25	178	.....	51.5	.....	.....	....	prr	AL.	M	Rotax	C. H.	.....
	Pegasus XXVII	A	9	Rad	G	830	2475	11000	87	1040	1.25	5.75x7.50	1753	6.572	151	.....	55.3	.....	.....	....	prr	S.	M	Rotax	C. H.	.....
	Pegasus XVIII	A	9	Rad	G	1000	....	3000	87	1135	1.13	5.75x7.50	1753	6.25	174	.....	53.3	61	.48	.018	prr	S	M	Rotax	Hobson	Rotax
	Perseus XIVC	A	9	Rad	G	710	2400	4000	..	1100	1.57	5.75x6.5	1520	.....	154	.....	52	.....	.....	....	..	.....	M	Rotax	C. H.	.....
	Perseus XVI	A	9	Rad	G	920	....	6500	87	1110	1.27	5.75x6.5	1520	6.75	176	.....	52	60	.46	.018	prr	.....	M	Rotax	Hobson	Rotax
	Hercules II	A	14	S. Rad	G	1150	2400	5000	..	1680	1.46	5.75x6.5	2360	.....	160	.....	52	52	.....	....	prr	.....	M	Rotax	C. H.	.....
	Hercules	A	14	Rad	G	1400	....	5000	100	1850	1.16	5.75x6.5	2360	6.75	183	.....	52	70	.45	.018	prr	.....	M	Rotax	Hobson	Rotax
	Taurus II	A	14	S. Rad	G	900	2800	5000	..	1300	1.44	5.00x5.6	1550	....	164	.....	46.25	.....	.....	....	..	.....	M	Rotax	C. H.	.....
	Aquila IV	A	9	Rad	G	470	2600	4500	73	830	1.76	5.00x5.37	950	....	150	.....	46	.....	.....	....	..	.....	M	Rotax	C. H.	.....
Blackburn Aircraft, Ltd.	Cirrus Major	A	4	L. Id	D	150	2450	S. L.	..	325	2.35	4.72x5.51	386	5.8	128	.....	29.96	42.91	.....	1-2	prr	S.	M	.....	C. H.	.....
De Havilland Aircraft Co., Ltd.	Gipsy Major II	A	4	L. Id	D	140	2400	S. L.	77	315	2.52	4.65x5.51	374	6:1	126	.....	32	50.35	.....	....	prr	S.	M	.....	Z	.....
	Gipsy Six	A	6	L. Id	D	205	2400	S. L.	77	469	...	4.65x5.51	564	6:1	126	.....	31.7	63.5	.....	....	prr	S.	M	.....	Z	.....
	Gipsy Twelve	A	12	IdV	G	425	2450	7500	..	1058	2.52	4.65x5.51	1121	6:1	123	.....	37.4	82.6	.478	....	prr	CB.-S.	M	.....	C. H.	.....
D. Napier & Son, Ltd.	Napier	A	16	(H)	G	395	4000	6000	..	707	1.98	3.5 x3.5	538.78	7:1	140	5.27:1	36	56.62	.427	.0315	prr	S.	M	.....	C. H.	.....
	Napier-Halford Dagger	A	24	(H)	G	955	4200	S. L.	87	1390	1.56	3.8 x3.75	1027	7.5	171	.....	47.81	73.87	.....	....	prr	S.	M	.....	C. H.	Rotax
	Napier Sabre	L	24	(H)	G	2.200	....	S. L.	..	....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	prr	.....	M	.....	.....	.....
Pobjoy Airmotors & Aircraft, Ltd.	Niagara	A	7	Rad	G	142	4600	S. L.	87	175	1.4	3.19x3.43	192	8.1	128	.....	26.5	.....	.....	....	prr	S.-Al.	M	Rotax	C. H.	.....
Rolls-Royce, Ltd.	Merlin IV	L	12	V	G	990	2600	12250	87	1335	1.35	5.4 x6	1647	....	183	.....	41.17	75.0	.....	....	prr	AL. CB. S.	M	.....	R.-R.	.....
	Peregrine	L	12	V	G	860	2850	13500	87	1106	1.28	5.00x5.5	1297	....	184	.....	.....	.....	.....	....	prr	AL. CB. S.	M	.....	R.-R.	.....
	Kestrel XVI	L	12	V	G	690	2500	3000	87	955	1.59	5.00x5.50	1297	6	162	.....	40.27	69.8	.....	....	prr	.....	M	.....	R.-R.	.....
	Merlin XX	L	12	V	G	1480	....	6000	100	1450	.98	5.4 x6	1649	6	238	.....	.....	70.6	.52	.022	prr	.....	M	Rotax	S. U.	BTH
	Merlin 45	L	12	V	G	1515	....	11000	100	1385	.91	5.4x6	1649	6	243	.....	.....	70.6	.52	.022	prr	.....	M	Rotax	S. U.	Rotax
	Merlin 61	L	12	V	G	1570	....	11500	100	1640	1.04	5.4x6	1649	6	251	.....	.....	78	.54	.022	prr	.....	M	Rotax	S. U.	Rotax
	Merlin LXI	L	12	V	G	.....	.....	.....	..	1640	....	5.4 x6	1647	....	...	.....	.....	.....	.....	....	..	.....	..	.....	.....	.....
	Vulture	L	24	X	G	1845	3000	5000	..	....	....	5.00x5.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
GERMAN																										
Argus Motoren G.m.b.H.	Argus As. 410	A	12	V. Id	G	465	3100	S. L.	..	694.5	2.06	4.1 x4.5	732.3	6.4	123	.....	38.18	62.4	.44	....	prr	S.-AL.	M	.....	.....	.....
Bayersiche Motoren Werke A.G.	B.M.W. 132	A	9	Rad	D	830	2150	3280	92	1015	1.24	6.12x6.37	1690	6.5	180	.....	54.33	49.29	.507	....	prr	S.-AL.	M	Bosch	Pallas	Bosch
	B.M.W. 801A	A	14	Rad	G	1460	2400	16250	92	2430	...	6.15x6.15	2558	6.5	...	5.07x1	52.	58.	.....	....	prr	S.	M	Bosch	.....	Bosch
	B.M.W. 801-D	A	14	Rad	G	1585	....	16400	92	1940	1.10	6.15x6.15	2558	6.5	182	.....	52	59.1	.45	.018	prr	S.	M	Bosch	Deckel	Bosch
	B.M.W. 802	A	14	Rad	G	2000*	....	.....	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Brandenburgische Motorenwerke.	Bramo Fafnir 323	A	9	Rad	G	920	2500	S. L.	..	1199	1.44	6.00x6.3	1636	6.4	173	.....	54.6	55.8	.....	....	prr	.....	M	.....	.....	.....
Diamler-Benz Aktiengesellschaft.	Mercedes-Benz D-B 600	L	12	V. Id	G	800	2200	S. L.	87	1200	1.5	5.91x6.3	2069	6.5	139	.....	39.37	67.7	.495	.0111	ohe	S.	M	Bosch	.....	.....
	Mercedes-Benz D-B 601	L	12	V. Id	G	1050	2500	S. L.	92	1268	1.27	5.91x6.3	2069	6.9	153	.....	40.5	67.5	.....	....	ohe	.....	M	Bosch	.....	.....
	Mercedes-Benz D-B601-E	L	12	V. Id	G	1375	....	18000	92	1400	.93	5.90x6.3	2069	6.9	202	.....	39.4	67.7	.44	.011	ohe	.....	M	Bosch	Bosch	Bosch
	Mercedes-Benz D-B601-N	L	12	V. Id	G	1270	....	16400	92	1400	1.10	5.90x6.3	2069	7.9	185	.....	39.4	67.7	.45	.011	ohe	.....	M	Bosch	Bosch	Bosch
Hirth Motoren G.m.b.H.	H.M. 506-A	A	6	L. Id	D	160	2500	S. L.	..	328	2.31	4.1 x4.52	364.7	6	119	.....	28.66	49.8	.495	....	prr	C.	M	Bosch	Pallas Zenith	.....
	H. M. 508D-1	A	8	V. Id	G	280	3000	S. L.	..	485	2.	4.1 x4.52	486.4	6	127	.....	32.05	51.5	.571	....	prr	C.	M	Bosch	Pallas Zenith	.....
	H.M. 512-A	A	12	V. Id	G	400	3100	S. L.	..	593	1.98	4.1 x4.52	728	6	116	4.4:1	32	61	.473	.005	prr	C.	M	Bosch	Pallas Zenith	.....
Junkers Motorenwerke A.G.	Die. Jumo 205-C	L	6	Vl-Opp	GI	510	2100	S. L.	..	1147	2.25	4.13x2.x6.3	1014	17	94	.....	52. 16	76.5	.385	.002	..	S.	.....	.....	.....	.....
	Jumo 210-B	L	12	V. Id	G	540	2600	S. L.	87	958	1.70	4.88x5.3	1202	6.5	136	.....	70.87	58.19	.....	....	prr	S.-AL.	M	.....	.....	.....
	Jumo 210-G	L	12	V. Id	G	700	2700	S. L.	..	983	1.40	4.88x5.3	.....	6.5	170	.....	37.91	58.19	.504	....	prr	S.-AL.	M	.....	.....	.....
	Jumo 211-C	L	12	V. Id	G	1000	2300	S. L.	..	1278	1.59	5.91x6.5	2136	6.5	...	.....	40.67	66.46	.....	....	prr	S.-AL.	M	.....	.....	.....
	Jumo 211-Ba	L	12	V. Id	G	1100	2400	S. L.	..	1356	1.24	5.91x6.5	.....	6.5	...	.....	41.69	68.7	.470	....	prr	S.-AL.	M	.....	.....	.....
	Jumo 211-J	L	12	V. Id	G	1300	....	12500	92	1450	1.12	5.90x6.5	2136	7	193	.....	41.3	69.7	.45	.018	prr	.....	M	Bosch	Junkers	Bosch
RUSSIAN																										
	M-38	L	12	V	G	1300	....	6600	95	1455	1.12	6.30x7.48	2807	6	161	.....	.....	78.7	.48	.022	prr	.....	M	Elec	Updraft	.....
	M-88	A	14	Rad	G	1100	....	7200	95	1323	1.20	5.75x6.50	2360	6.1	152	.....	50.8	59.1	.48	.018	prr	.....	M	Elec	Updraft	.....
	M-105P	L	12	V	G	1000	....	7200	95	1268	1.15	5.90x6.69	2197	7	152	.....	.....	79.8	.48	.018	per	.....	M	Elec	6 Updraft	.....
JAPANESE																										
Mitsubishi	Kinsei 4	A	14	Rad	..	1075	....	13100	92	1200	1.12	5.50x5.90	1971	6.6	172	.....	58	65	.45	.022	..	.....	..	Kokusan	Nakajima	Mitsu
Nakajima	Sakae NK-1	A	14	Rad	..	900	....	13100	92	1166	1.16	5.12x5.90	1700	6.5	179	.....	44.1	66.2	.45	.022	..	.....	..	.....	.....	.....
	Sakae NK-2	A	14	Rad	..	1100	....	16400	92	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* —Approximately.
A. —Air cooled.
Al. —Aluminum.
C. —Cast iron.
CB. —Carbon steel.
C.H. —Claudel-Hobson carburetor.
Cr. —Chrome.
CR. NC. —Chrome nickel.
D. —Direct.
DM. —Dual Magneto.
Die. —Diesel engine.
Ed. —Eclipse.
Elec. —Electrozavod.
G. —Geared.
G 1.—7:5 reduction gear.
H. —Horizontal.
(H). —Cylinders in H.
Hi. —Hidurninium alloy.
Id. —Inverted.
L. —Cylinders in line.
M. —Magneto.
Mitsu. —Mitsubishi.
Mb. —Molybdenum.
N. —Nitrided.
NI. —Nickel iron.
Opp. —Opposed.
ohe. —Overhead cam.
prr —Push rods and rocker arms.
Rad. —Radial.
S.Rad. —Staggered radial.
S.L. —Sea Level.
S. —Steel.
V. —Vee.
VI. —Vertical.
W. —Liquid cooled.
Z. —Zenith.
1-2-3 —BMW, Diamler-Benz and Junkers are fuel

Aviation's Russian Aircraft Specifications

General				Power Plant				Performance							Weights		Dimensions			Area
Designation or Model No.	Type	Number of seats	Number and Make of Engine	Total rated hp. ea.	At altitude, ft.	Normal range (mi.)	High speed (m.p.h.)	At altitude, ft.	Cruising speed (m.p.h.)	At altitude, ft.	Stalling speed (m.p.h.)	Climb at sea level (ft. per min.)	Service ceiling (ft.)		Weight empty	Gross weight (lb.)	Span	Length overall	Height overall	Wing (including ailerons)
DI-6	Fighter	OBL	2	1 M-63	1,000		530	240						31,820		4,290	35′ 3″	25′ 7″		
I-15	Fighter	OBL	1	1 M-25	750		465	223						25,500		4,140	33′ 5″	20′ 10″		
I-15bis	Fighter	OBL	1	1 M-63	1,000		500	217									33′ 5″	20′ 10″		
I-16	Fighter	OML	1	1 M-63	1,000		465	280		225				28,500		3,190	29′ 2″	20′ 4″		
I-16e	Fighter	OML	1	1 M-88	1,100			300	15,000					32,000			31′ 3″	23′		
I-17	Fighter	CML	1	1 M-100	1,100		600+	310		273				36,000		4,230	33′ 1″	24′ 2″		
I-19	Fighter	CML	1	1 Toupolev	1,300			400												
I-20	Fighter	CML	1	2 Toupolev	1,300			378												
I-21	Fighter	CML	1	1 M-2	1,600			370							6,090	7,480	31′ 9.5″	28′ 7″		188
LA-5	Fighter	OBF	1	1 M-17 BMW	680		310	150						23,900		2,900	37′ 4″	23′ 10″		
MI-1	Fighter	CML	1	1 AM-35a	1,200												37′ 6″	31′ 2″		
MIG-1	Fighter	CML	1	1 M-105p	1,100											6,000	36′	30′		
YAK-9	Fighter	CML	1	1 M-63	1,000			248									32′ 10″	20′ 2″		
I-153	Fighter-Bomber	CML	1	1 M-105p	1,100	SL	400	318	16,500	279	16,400	87	2,000	30,000	5,770	7,050	31′ 9.5″	20′ 5″	8′ 4″	188
LAGG-3	Fighter-Bomber	CML	1	1 AM-35A	1,250	19,680	500	380	21,000							6,200	37′ 6″	31′ 2″		
MIG-3	Fighter-Bomber	CML	1	1 Toupolev	1,300			400								6,000	38′	32′	10′	281
YAK-1	Fighter-Bomber	CML	1	1 M-105p	1,100											6,000	36′	30′		
YAK-2	Fighter-Bomber	CML	1	1 M-88	1,100			275												
SU-2	Fighter-Bomber	CML	2	1 M-88	1,100			280								15,000	70′ 6″	40′		
AR-2[1]	Attack-Bomber	CML	3	2 M-105	1,100		500	280	13,000					28,000			47′ 11″	38′	10′ 9″	
IL-2	Attack-Bomber	CML	1	1 AM-38	1,300			280	13,000					28,000			47′ 11″	38′	10′ 9″	
IL-3	Attack-Bomber	CML	2	1 AM-38	1,300			270									94′ 1″			
MTB-1	Attack-Bomber	CMF	5	2 M-17	680		935	120									70′ 2″	46′ 10″		
DB-3	Medium Bomber	CML	3–4	2 M-87b	950		2,500	279	10,000							30,000	70′ 2″	47′ 6″		
DB-3F	Medium Bomber	CML	3–4	2 M-88	1,100		2,500	300	21,000	186				30,000		33,000	70′ 2″	47′ 6″		
SB-1	Medium Bomber	CML	3	2 M-25	630			217									70′ 6″	40′		
SB-2	Medium Bomber	CML	3	2 M-63	1,000		500	274								14,300	70′ 6″	40′		
SB-2bis	Medium Bomber	CML	3	2 M-103	950		500	279								15,000	70′ 6″	41′ 6″		
SB-3	Medium Bomber	CML	3	2 M-12 H-S	950		550+	280		220	14,400						66′	41′ 6″		
SB-RK	Medium Bomber	CML	3	2 M-105	1,100			280+		220+							70′ 6″	40′		
TB-1	Medium Bomber	CML	4–5	2 M-17 BMW	680		620	128						17,500		17,440	94′ 1″	59′		
ZKB-26	Medium Bomber	CML	5	2 M-85	1,000			310												
TB-3B	Heavy Bomber	CML	8	4 M-34	830		620	155						16,400		33,000				
TB-6B	Heavy Bomber	CML	8	4 M-100 H-S	1,100		1,200	230						26,000		50,000	120′			
TB-7	Heavy Bomber	CML	11	4 AM-38	1,300		2,500	280	25,000	210				26,000		49,280	131′ 2″	73′ 10″		
ER-2	Bomber			2 inline																
PE-2	Reconn-Bomber	CML	3–4	2 M-105	1,100			310						32,000			56′ 11″	41′ 3″	13′	592
PE-3	Reconn-Bomber	CML	4	2 M-103	1,100			310									56′ 5″	39′ 4.5″		
YAK-4	Reconn-Bomber	CML	3	2 M-105	1,100			315												
R-10	Reconn-Bomber	CML	2																	
ANT-25	Reconnaissance	CML	3	1 AM-34r	1,000		6,000	150								24,750	111′ 6″	43′ 11″		
R-2	Reconnaissance	OBL	2	1 M-34	830		500	175												
R-3	Reconnaissance	OBL	2	1 M-22	480		425	140						19,350		5,280	42′ 6″	31′ 2″		
R-5	Reconnaissance	OBL	2	1 M-17 BMW	680		620	140		100				22,900		6,150	50′ 9″	34′ 7″		
R-6	Reconnaissance	CML	3	2 M-17 BMW	680		550	170						22,900			41′ 3.5″			
ANT-9	Transport	CML	11	3 M-26	300		550	130					400	12,500	7,376	11,000	77′ 10″	55′ 10″	15′ 10″	904
ANT-14	Transport	CML	12	5 M-22	480		725	135								38,200	132′ 6″	87′		
KAL K-5	Transport	CML	2	1 M-17	680			123								7,716	67′ 2.5″	51′ 6″		
L-760	Transport	CML	10	6 M-100 H-S	1,100		1,860	185								103,000	210′		30′*	5,228
PS-35	Transport	CML	2	2 M-85	850		1,242	250						27,880		14,500	68′ 2″	49′ 2″		
PS-84[3]	Transport	CML	2	2 M-63	1,100		1,620	230	8,500	185	10,000					26,000	95′	64′ 6″	16′ 11″	
PS-89	Transport	CML	2	2 M-22	480			155												
STAL-2	Transport	CML	1	1 M-26				127								3,980	49′ 11″	32′		
STAL-3	Transport	CML		1 M-22	480			124								33,000	138′	87′		
STAL-11	Transport	CML		2				252								6,864	49′ 2.5″			
TB-3	Bomber-Transport	CML	6–8	4 M-34	830		800	124								33,000	138′	87′		
ARK-3	Reconnaissance	CMF	2	2 M-25 Cy	630		960	200						16,400		11,286	65′ 6″	47′ 5″		
KOR-1	Reconnaissance	OBFL	2	1 M-63	1,000															
MBR-2	Reconnaissance	CMF	5	1 M-17 BMW	680		750	140						17,050			44′			
MBR-5	Reconnaissance	CBF	3	1 M-17 BMW	680		620	140								6,780	51′ 2″	37′ 6″		
MDR-6	Reconnaissance			2 radials																
GST[3]	Reconnaissance	CMF	6–9	2 P&W	1,200		4,000	190	10,500				1,100	25,200		27,080	104′	62′ 6″	18′ 6″	1,400
P-2	Primary Trainer	OBL	2	1 M-11	110		250	93								1,892	37′ 5″	26′ 8″		
UT-1	Primary Trainer	OML	1	1 M-1	120			120												
UT-2	Primary Trainer	OML	1	1 M-11	110			120												
I-16B	Advanced Trainer	CML	1	1 M-63	1,000		460	290								6,100	31′ 3″	21′ 11″		
YAK-7	Advanced Trainer	CML	2	1 M-105	1,100												32′ 10″	27′ 10″		
G-22	Advanced Trainer	OML	1	1 inline	50			110	S.L.	100		35			485	749	28′	17′		

[1] Believed to be modification of SB-2. [2] Douglas DC-3 design, built under license. [3] PBY design, built under license.

Aviation's Glider Specifications

Designation	No. seats	Speeds		Weights			Dimensions			Area (Sq. Ft.)						Wings		
		High speed	Stalling speed	Net	Gross	Wing loading	Span	Length	Height	Wing (inc. aileron)	Aileron	Fin	Rudder	Stabilizer	Elevator	Spar	Ribs	Covering
AMERICAN																		
Bowlus BA-100	1	65	28		450	3.5	44′ 4″									W	W	WFab
Briegleb BG-6	1	72	30		425	3.63	32′ 3″		4′ 3″	117	18	7	7	8.8	7	Sp		Fab
BG-8	2	90	40		1,006	5.3	50′ 3″		5′ 4″	190	31.14	3	9	15.75	11	W		W
Bristol Aeronautical Co. LRG-1	12				6,500+		72′	40′										
Calif. Aero Glider Co. J-14	2		30	360	740	3.0	45′	23′ 6″		225						SolW	Trs	Fab
Gen'l Airborne Transport XCG-16							91′ 9″	48′ 3″								W	W	W
Laister-Kauffman Aircraft Corp. XCG-10A[1]							105′	67′		1171		97.3	58	110	82	W	W	W
Pratt Read & Co., Inc. LNE-1	2	99	35	770	1,150	5.0	54′ 6″	26′ 3″	9′ 2″	213.86	30.2	6.9	12.03	9.02	14.2	W	W	Fab
Schweizer Aircraft Corp. TG-2	2	72		460	860	4.01	52′	25′ 3″	6′ 10″	214	21.25	2.79	12.82	13.5	10.4	Me	AlFab	Al
TG-3A	2	100		800	1,220	5.15	54′	27′ 7″	8′	237	17.37	5.42	11.35	16	13.10	Sp	SpPly	Fab
Waco Aircraft Co. CG-4A[2] (LRW-1)	15	150	44	3,000+	6,000+	8.8	83′ 8″	48′ 2.5″	11′ 7.5″	851.5	85.4	20.8	29.0	59.4	54.6	SpPly	Sp	PlyFab
CG-13[3]	30	175	80	7,000	17,000		85′ 6″*	54′+								W	W	Ply
BRITISH																		
Airspeed Horsa	25			8,370	15,500	14.05	88′	67′	19′ 6″	1104						W	W	WFab
General Aircraft Hotspur II		90		1,661	3,598	14.7	45′ 10.75″	39′ 8.75″	10′ 10″	272						W	W	Ply
Hamilcar I				18,500	36,000		110′	68′ 1″	20′ 3″	1657.5								
GERMAN																		
Gotha DFS 230A1	10			1,700	4,500		69′ 11″	37′										
GO 242	23			3,200	8,500		79′	52′ 6″										

[1] Can carry six tons of cargo. Has retractable tricycle landing gear, as does XCG-16.
[2] Also built under license by Commonwealth, Ford, G & A Aircraft, General Aircraft, Gibson Refrigerator, Laister-Kaufman, Northwestern Aeronautical and Pratt Read & Co.
[3] Only other releasable data is fact that the craft carries more than twice the load of the CG-4. It is being manufactured by Ford and Northwestern Aeronautical Corp.

Aviation's Helicopter Specifications

Manufacturer	General: Designation or Model No. — Army or Navy	General: Designation or Model No. — Company	General: Type	General: Number of seats	Power Plant: Make of engine	Power Plant: Total rated hp. each	Power Plant: At altitude, ft.	Performance: Fuel capacity, gal.	Performance: Normal range, mi.	Performance: High speed	Performance: At altitude, ft.	Performance: Cruising speed	Performance: At altitude ft.,	Performance: Climb at sea level	Performance: Service ceiling
Aeronautical Products, Inc.	.....	Model 3-A	CL	2	1 Franklin	150	SL	20	175	100	SL	80	SL	1,100	11,000
Bell Aircraft Co.[1]	.....	.....	CL	2	1 Franklin	160	SL	.....	.....	100	.....	80–90	.....	480+	.....
Bendix Helicopters, Inc.[2]	.....	Model G	CL	2	1 Warner	165	SL	35	300	120	.....	100	.....	480	.....
	.....	Model I	CL	4	1 Warner	300	SL	75	420	120	.....	105	.....	900	.....
Consolidated-Vultee, Stout Div.[3]	.....	Helicab	CL	2–5	1	125	.....	.....	.....	.....	.....	.....	.....	.....	.....
Curtis Wright Industries[4]	.....	Flymobile 1	CL	1	1 Franklin	90	SL	5	40	95	.....	80	.....	900	5,000
Fleetwings Div., Kaiser Cargoes, Inc.[5]	.....	Model H-10	CL	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Greyhound Bus Lines[6]	.....	.....	CL	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hartwig-Little Co.[7]	.....	HL-1 Little 'Copter	CL	2	1 Franklin	90	SL	20	300	125	1,500	100	1,500	600	7,000
Rotor plane Div., Higgins Industries[8]	.....	EB-1	CL	2	1 Warner	180	.....	.....	.....	125*	.....	.....	.....	.....	.....
Hiller Industries	.....	HX-44 Hiller-copter	CL	1	1 Franklin	90	SL	8	200	100	500	85	500	600	8,000
Kellett Aircraft Co	XR-8	KH1X	.....	2	All other data restricted										
Landgraf Helicopter Co.[10]	.....	H-2	CL	1	1 Pobjoy R	85	SL	6.5	.....	.....	.....	.....	.....	.....	.....
Penn. Aircraft Syndicate[11]	.....	18–80 Gyrocopter	CL	18	2 Wright Cyclone	1,000	8,000	300	360	135	SL	119	SL	750	18,000
P-V Engineering Forum[12]	.....	PV-2	CL	1	1 Franklin	90	SL	.....	.....	90–100	.....	85	SL	1,100	10,000
Platt LePage Aircraft Co	R-1A[13]	.....	CL	2	1 P&W Wasp	450	SL	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	CL	12–14[14]	2	800	.....	.....	.....	140	.....	100–110	.....	.....	.....
Rotor-Craft Corp.[15]	.....	X-2	.....	2	1 Continental	85	SL	6	.....	.....	.....	.....	.....	.....	.....
Arthur C. Schouw	.....	H-100[16]	CL	2	1 Continental	105	.....	.....	.....	110	.....	95	.....	.....	.....
Sikorsky Div., United Aircraft Corp.	R-4B(HNS)[17]	VS-316A	CL	2	1 Warner R-500	185	SL	.....	.....	.....	.....	.....	.....	.....	10,000
	R-5	.....	CL	2	1 P&W Wasp Jr.	450	SL	.....	.....	.....	.....	.....	.....	.....	.....
	R-6[18]	.....	CL	2	1 Franklin	245	SL	.....	450*	100	.....	.....	.....	.....	.....
Twin Coach Co.	.....	TCD Hover-Twin[19]	CL	2	2 Continental A-75	75	SL	15	175	100	SL	75	SL	2,000*	.....
														500	.....

Manufacturer	Weights: Gross wt.	Weights: Net wt.	Weights: Rotor disc loading	Weights: Power loading	Main Rotor Data: No. of rotor blades	Main Rotor Data: Diameter	Main Rotor Data: Chord	Main Rotor Data: Rotor blade area (total)	Main Rotor Data: Rotor rpm. crusing	Main Rotor Data: Spar construction	Main Rotor Data: Blade covering	Anti-Torque Rotor Data: No. blades	Anti-Torque Rotor Data: Diameter	Anti-Torque Rotor Data: Chord	Anti-Torque Rotor Data: Rotor rpm. (crusing)	Anti-Torque Rotor Data: Spar construction	Anti-Torque Rotor Data: Blade covering	Fuselage: Construction	Fuselage: Covering	Landing Gear: Type	Landing Gear: Shock unit	Landing Gear: Tread
Aeronautical Products, Inc.	1,650	1,100	2.34	11.0	3	30′	12″	45	250	ST	Fab	2	5′ 8″	6″	1,500	ST	Fab	ST	Fab	Wh. Sk.	Hyd	7′ 6″
Bell Aircraft Co.[1]	1,400*	.....	.....	.....	2	33′	.....	.....	.....	Sol W	.....	2	5′	.....	.....	Sol W	.....	ST	Fab	Fx.Tri.	Hyd	.....
Bendix Helicopters, Inc.[2]	2,000	1,374	2.48	12.1	4-co	32′	.....	.....	250	.....	.....	.....	none	.....	.....	.....	.....	Me	.....	Fx.Fl.	Ol	.....
	3,036	1,925	2.41	10.64	4-co	40′	.....	.....	215	.....	.....	.....	none	.....	.....	.....	.....	Me	Me	Fx.Tri.	Ol	9′
Consolidated-Vultee, Stout Div.[3]	1,700*	.....	.....	2	33′	.....	.....	.....	.....	.....	.....	2	6′	.....	.....	.....	.....	S.Al.	Plastic	Fx.Tri.	.....	.....
Curtis Wright Industries[4]	1,100	900	2.1	12.2	4-co	25′	12″–10″	40	325	S.Al	M	.....	none	.....	.....	.....	.....	T	Fab	3 Wh.	Spr.	.....
Fleetwings Div., Kaiser Cargoes, Inc.[5]	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	5	.....	.....	.....	.....	.....	.....	.....	Fx.Tri.	.....	.....
Greyhound Bus Lines[6]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hartwig-Little Co.[7]	1,600	1,080	1.925	17.75	4-Ta	23′	20″	53.33	317	T	Ply	..	none	.....	.....	.....	.....	W	Ply	Tri.	Sh. cord	.....
Rotor plane Div., Higgins Industries[8]	.....	.....	.....	.....	4	32′	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	Me	Fab	Fx.Tri.	.....	.....
Hiller Industries	1,400	1,200	2.86[9]	15.5	4-co	25′	14″	48	250–350	Me	Me	..	none	.....	.....	.....	.....	T	Fab	Fx.3 Wh.	.....	8′
Kellett Aircraft Co.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Landgraf Helicopter Co.[10]	850	636	2.36	10	6	16′	.72	32.4	440	Sol W	Ply	..	none	.....	.....	.....	.....	W Mo	Ply	Re Tri.	Pn Ol	5′ 9″
Penn. Aircraft Syndicate[11]	16,000	10,000	3.2	8	3	80′	5′–2″	240	150	Me	Me	3	14′	1′	1,500	.....	.....	Al	Al	Fx	Hyd	16′
P-V Engineering Forum[12]	1,000	750	2.04	11.1	3	25′	9.5″	19.6	371	ST	Fab	2	5′	.....	1,670	W	Ply	ST	Fab	Wh-Sk	SprHyd	8′
Platt LePage Aircraft Co.	4,800*	.....	.....	.....	6	30′ 6″	.....	.....	.....	.....	.....	.....	none	.....	.....	.....	.....	.....	.....	.....	.....	.....
	7,000	.....	.....	.....	6	.....	.....	.....	.....	.....	.....	.....	none	.....	.....	.....	.....	.....	.....	Re	.....	.....
Rotor-Craft Corp.[15]	950	625	20	11	6	16′	8″	33	490	W	W	..	none	.....	.....	.....	.....	ST	Ply	Tri.	Pn Ol	6′ 8″
Arthur C. Schouw	.....	.....	.....	.....	.....	10′	.....	.....	240	.....	Fab	.....	.....	.....	.....	.....	.....	Me	Me	Fx.Tri.	.....	.....
Sikorsky Div., United Aircraft Corp.	2,530	2,011	.....	.....	3	38′	Taper	.....	.....	.....	Fab	3	7′ 8″	Taper	.....	W	Fab	ST	Fab	Fx Wh Sk	Ol	10′
	4,800	3,725	.....	.....	3	46′	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	Me	Me	Fx.3 Wh.	.....	.....
	2,600	2,016	.....	.....	3	38′	.....	.....	.....	.....	.....	3	7′+	.....	.....	.....	.....	Me	Me	Fx.4 Wh.	.....	.....
Twin Coach Co.	1,645	1,080	1.8	11	4-co	30′	18″	78	280	Ply	Fab	...	none	.....	.....	.....	.....	T	Fab	Fx	Rubber	9′ 2″

[1] Second of two experimental models on which development work is continuing.

[2] Also building Model H, 500-hp. cargo carrier convertible for passenger use. Model I climb-rate is on inclined path.

[3] Under development.

[4] A West Coast organization unrelated to Curtiss-Wright Corp. First model scheduled for completion Dec. 1944; second model, four-place, being designed.

[5] Although no data has been released, prototype is reported to have undergone initial flight tests.

[6] A design by Raymond Loewey. Greyhound has applied to CAB to operate such craft over some 49,000 route-miles.

[7] Employs two contra-rotating tandem rotors set on shafts extending from fore and aft ends of fuselage, aft rotor being set highest. During initial flight tests craft lifted 1,700 lb.

[8] Designed under supervision of Eneas Bossi; prototype has been built but no information is available on test flights.

[9] Blade loading given as 29.2 lb-sq.ft. Rotor spar is all-metal rigid type. Production model is expected to have 450-mi. range.

[10] Prototype has been built and some flight testing made. Attitude control is by means of cyclically-operated ailerons on rotor blades. Rigid blades have automatic but not cyclic pitch control. (Also see Aviation, Oct., 1944, p. 186; Nov., 1944, p. 205; and this issue's Sketch Book of Design Detail, p. 193).

[11] Data based on engineering data and wind tunnel test model. Will utilize cyclic feathering semi-rigid rotor system, and will be equipped for feeder or short haul postwar service.

[12] Experimental model built primarily for test purposes; larger model to have payload of more than a ton and range of approximately 400 mi. has been designed. PV-2 rotor blades have tubular steel spar with wood ribs, leading and trailing edges, all fabric-covered. (Also see Aviation for November, 1943, page 223.)

[13] Contra-rotating rotors mounted on streamlined cantilever booms extending out from sides of fuselage. Main landing gear wheels attach to booms approximately one-quarter of distance to rotor blade hubs. Although no anti-torque rotor is utilized, craft has vertical and horizontal stabilizing surfaces much like those on conventional aircraft, with horizontal unit set well above fuselage. Prototype delivered to Army Air Forces.

[14] Proposed postwar transport on which design work has been going forward. Two engines provided for safety factor, as design indicates either engine could drive rotors. Operating costs said to be in line with other aircraft types of comparable capacity. Empennage greatly resembles that on R-1A except that horizontal stabilizer is set lower. Main wheels of landing gear retractable.

[15] Employs two three-blade rotors, set in tandem. Rotors have rigid blades without drag or flapping hinges. Control is by means of cyclic and collective pitch change. This model being constructed as experimental unit. Figure under "rotor disc loading" is rotor blade loading.

[16] Contra-rotating rotors mounted on cantilever booms extending out and up from fuselage just behind pilot's compartment. A propeller mounted in aft end of fuselage gives forward speed when control wheel is pushed forward; as wheel is pulled back direction of propeller is reversed to move craft backward. Prototype is under construction.

[17] First helicopter to be put in quantity production and first to be accepted for military service.

[18] Tandem seater being manufactured by Nash-Kelvinator under license. Nash-Kelvinator is reported considering postwar production of a commercial version.

[19] Prototype under construction. Provision made for minor variation in torque to assist turning in either direction. Twin engine installation for added safety factor, since design calls for maintaining flight on either engine.

Aviation's American Aircraft Specifica

Manufacturer	Designation or Model No. (Army or Navy)	Designation or Model No. (Company)	A.T.C. number	Type	Number of seats	Make of engine	Total rated hp. each	At altitude, ft.	Fuel capacity, gal.	Normal range, mi.	Propeller diameter, in.	Dimensions: Span	Dimensions: Length overall	Dimensions: Height overall	Area (Sq. Ft.): Wing (including ailerons)	Area (Sq. Ft.): Ailerons (total)	Area (Sq. Ft.): Fin	Area (Sq. Ft.): Rudder	Area (Sq. Ft.): Stabilizer	Area (Sq. Ft.): Elevators (total)	Weights: Wing loading (lb. per sq. ft.)	Weights: Power loading (lb. per hp.)	Weights: Weight empty	Weights: Gross weight, lb.	Performance: High speed, mph.	Performance: At altitude, ft.	Performance: Cruising speed, mph.	Performance: Range, miles	Performance: Service ceiling	Performance: Rate of climb, ft. per min.	Performance: Take-off run, ft.	Performance: Landing run, ft.	Performance: Tread
Aeronca Aircraft Corp.	L3-C	O-58B		CLM	2	1 Continental	65	SL	12	218	72	35′	21′ 10″	9′ 1″	169	15.52	5.51	6.8	13.66	1.54	7.69	20	793	1300	87	SL	70	11,000	700	1000	1000	1000	7′ 6″
		Chief		CLM	2	1	65	SL	24	420		36′	20′ 10″		175						7.4	19.2	825	1250	100	SL	80						
		Champion		CLM	2	1	65	SL	15	270		35′	21′ 6″		170						7.2	18.8	710	1220	100	SL	80						
		Arrow		CLM	2	1	90	SL	25	500		30′			137						10.6		850	1450	135	SL	100						
		Eagle		CLM	4	1																											
Allied Aviation Corp.		Trimmer		CAM	3	2 Continental	85	SL	45	250–600	74	35′ 6″	24′ 10″	8′ 7″	163.6	16.25	9.5	8.75	14.5	11	13.45	12.92	1520	2200	135	SL	90	11,000	1000	1500	1000	1000	7′ 6″
Andover Kent Aviation Corp.		Langley XNL-1	755	CLM	4	2 Franklin	90	SL	35	350	60	35′	20′ 10″	7′ 1″	171.5	16.66	4.06	3.98	18.8	10.65	15.45	14.70	1738	2650	138	SL	90						
Beech Aircraft Corp.	UC-45A Voyager	18		CLM	8	2 P & W	450	SL		1000		47′ 8″	34′ 3″	9′ 5″	347								5025	7500	223	SL	90						
	UC-43C Traveler	F17D	689	CLB	5	1 Jacobs L-6	300	SL	77			32′	26′ 1″	8′	296.4	22.96	6.5	8.71	24.48	16.56											
	AT-10 Wichita			CLM	2	2 Lycoming	295	SL	128	765	99	44′	32′ 2″	10′ 2″	298	20.8	15.2	16.14	40.8	26.22	20.1	10.15	4749	6000	200	SL	80						
Bell Aircraft Corp.	P-39Q Airacobra	26		CLM	1	1 Allison	1150	12000	104		124.5	34′	30′ 2″	9′ 3″	213.2	15.46	7.9	11.	24.1	16.8	35.5	6.58	5523	8000	390+		350						
	P-59A Airacomet			CLM	1	2 GE I-16 turb.							49′	38′ 10″	400									10000	400+							
	P-63B Kingcobra			CLM	1	1 Allison V-1710	1500			1000+		38′6	32′ 4	9′ 8″4									6000*	50	400+							
		Cruisair 14-12-3	745	CLM	1	1 Franklin	120	SL	20	400		34′ 2″	23′	6′ 3″	140						13.5	15.8	1140	1900	150	SL	120						
Reliance Aircraft Corp.				CLM	3	1 Wright 1820	1200	SL		3000	139	103′ 9″	74′ 9″	19′ 1″	1420	69.5	142.9	37.8	203	114.7	38.45	13.75	38200	65000	300+		250						
Boeing Aircraft Corp.	B-17G[1]	Flying Fortress 299		CLM	6–10	4 Wright 3350	2200			3000+	199	141′ 3″	99′	27′ 9″	1750.8	129.2	172.6	65.2	218	115	70+	13.6	70000	130000	300+		250						
	B-29A[3]	Superfortress 345		CLM	11	4 Wright	1200	SL	1800	1500	139	107′ 3″	74′ 2″	19′ 1″	1485.8	69.5	109.3	39.8	230	98.2			32646	54050	255		215						
		Stratoliner SA-307B[2]		CLM	41	4 Wright	1200	SL	5400	4900	177	152′	106′	27′ 7″	2867	163	254.4	89.9	329.9	183.2	29.3	13.1	49149	84000	238		220						
		Clipper 314		CMF	89	4 Wright	1600	SL	5400	4900	177	152′	106′	27′ 7″	2867	163	254.4	89.9	329.9	183.2	29.3	13.1	49149	84000	238		220						
		Stratocruiser 377-2[4]		CLM	100	4 radials	3000	SL	7055	3500	199	141′ 3″	110′ 4″	33′ 3″	1750.8	129.2	172.6	65.2	218	115			69600	130000	400		340						
															24.2								23400	33800								
Edward G. Budd Mfg. Co.	RB-1(C-93)	Conestoga		CLM		2 P & W				1700		100′	68′								8.53	15.5	1050	1550	112	SL	95						
Fairchild Aircraft Co.		Callair A	758	CLM	2	1 Lycoming	100	SL	25	342	74	35′ 10″	22′ 7″	7′	181.6	21.4	8.6	10	15.8	14.0			4100	5700	135		120						
Cessna Aircraft Co.	AT-17 Bobcat			CLM	4	2 Jacobs L4MB	225	SL	150	550	93	41′ 11″	32′ 9″	9′ 2″	295.9	18.	10.89	14.87	39.22	23.46	13.3	11.2	1472	2158	158	SL	130						
Consolidated-Vultee Aircraft Corp.	L-5	Sentinel		CLM	2	1 Lycoming	190	SL	25	257	85	34′	24′	7′ 1″	155	16.75	9.71	7.05	21.8	15.62	13.3	11.2	1472	2158	158	SL	130						
	AT-19 (C-81)	Reliant		CLM	3	1 Lycoming	290	SL	70	555	102	41′ 11″	29′ 4″	8′ 7″	258.5	22.02	12.82	14.45	25.06	19.94	15.4	14.3	2810	4600	141	SL	120						
	BT-13(SNV)	Valiant		CLM	2	1 P & W	450	SL	120	516	108	42′	28′ 10″	18′ 4″	239	18.2	8.06	10.56	24.41	19.22			3345	4360	166	SL	140						
	A-35	Vengeance		CLM	2	1 Wr.	1700	SL		1500+		45′	40′	13′											250+							
	B-24M[4](PB4Y)	Liberator		CLM	5–10	2 P & W	1200	SL		4000*	139	110′	66′ 4″	18′	1048	64.3	123	48.8	140.5	192	50	11	34933	56000+	320+		250						
	C-87(RY-1)	Liberator-Express		CLM	5	4 P & W	1200	SL		4000*	139	110′	66′ 4″	18′	1048	64.3	123	48.8	140.5	192	50	11			320+		250						
	PBY-5A(OA-10)	Catalina		CLM	5	2 P & W	1200	SL		2520	145	104′	63′ 10″	18′ 11″	1400						25	14.6	20039	35000	196		150						
	PB2-Y3	Coronado		CFM	7	4 P & W	1200	SL		3500+	150	115′	79′ 3″	27′ 6″	1078						38	13.7	39332	66000	200+		180						
		Liberator Liner (39)		CLM	56	4 P & W	1350	SL		3000+	133	110′	90′	28′ 6″	1048	83.2	80.21	56.7	189.2	101.7	16.1	16.	30928	64000	266+		215						
	B-32	Dominator		CLM		4 Wright	2000+																										
		37		CLM		6 pushers									Large post war transport																		
		Voyager (125)		CLM	3	1 Lycoming	125	SL		470		34′	23′ 6″										1118	1375	123	SL	90						
		LFA Cadet		CLM	2	1 Franklin	80	SL	20	480	70	27′	17′ 8″	5′ 6″	120	9.22	3.77	3.57	12.40	5.26	10.88	16.3	860	1305	140	SL	100						
		LCA		CLM	2	1 Continental	75	SL	20	480	70	27′	17′ 8″	5′ 6″	120	9.22	3.77	3.57	12.40	5.26	10.88	17.4	820	1305	140	SL	100						
		Warhawk		CLM	1	1 Allison 1710	1395			1000		37′ 4″	33′ 4″	10′ 7″							38.5	7.32	6590	9000	350+		300						
Curtiss-Wright Corp.	P-40N			CLM	1	2 P & W R-2800	2000	SL		1500	161	108′ 1″	76′ 4″	21′ 9″	1360	79.2	115.4	52.8	158.5	98.4	33.09	14.06	29438	48000	365+		300						
	C-46B(R5C)	Commando		CLM	36–42	2 Wr. C-18-B2	2200				175	108′	76′ 4″	21′ 9″	1360	79.2	115.4	52.8	158.5	98.4	33.09	14.06	32100	48000	265+		215						
		Commando (CW-20E)																															
Douglas Aircraft Co.	SB2C[5](A-25)	Helldiver		CLM	2	1 Wr.	1700			1200		49′ 9″	36′ 8″	16′ 11″											300							
	A-20J&K	Havoc		CLM	3	2 Wr. R-2600	1825		540	1050	125	61′ 4″	48′	18′ 1″	464.1	42.1	25	35.2	60.8	39.7	43.01	7.4		20000	350+		300						
	A-26B&C	Invader		CLM	3	2 P & W R-2800	2000					70′	51′ 2″											27500+	350+		300						
	BTD																																
	C-47 (R4D)	Skytrain (DC-3)		CLM	32	2 P & W	1050	7500	822	2000+	138	95′	64′ 6″	16′ 11″	987	102.8	47.1	46.3	127.9	82.3	25.3	12.0	16970	29000	230	SL	200						
	C-54B(R5D)	Skymaster (DC-4)		CLM	49	4 P & W R-2000	1450		2877	3610	156	117′ 6″	93′ 11″	27′ 7″	1457	85.4	134.3	47.6	238.3	86.6	48.9	12.3	39000	71300	280		240						
		DC-6		CLM	55	4 P & W R-2800	2100		2577	2715	157	117′ 6″	100′ 7″	28′ 5″	1457	84.1	136.5	49.5	284.9	112.5	55	9.6		80500	334		300						
				CLM	26	2 In Line	700		300	600		86′ 7″	57′ 2″	22′									10680	17300								
		Skybus		CLM	118	4 P & W Major	3000			4000+		173′ 3″	123′ 4″	43′ 8″									85890	162000	400*		300						
		DC-7		CLM		4 P & W R-1820	1350			1000+		38′	29′ 4″	9′ 8″	260										300+							
Eastern Aircraft Div.	FM-2[7]			CLM	2	1 Wr. GR-1820	1350					38′	29′ 4″	9′ 8″											300+							
Engineering & Research Corp.		Ercoupe	718	CLM	2	1 Continental	65	SL	23	525	72	30′	20′ 9″	5′ 11″	142.6	16.8	3.3	6	10.2	9.4	8.8	19.4	725	1260	117	SL	95						
Fecheman		FW-5		CLM	4	1 Lycoming	235	SL		700					232								1507	2650	180		150						
Fairchild Engine & Aircraft Corp.	PT-19A	M62-A		OLM	2	1 Ranger	175	SL	45	430	86	37′	28′	7′ 6″	200	16.72	6.15	14.5	26.77	13.23	12.6	14.4	1851	2518	125	SL	100						
	UC-61K	24R		CLM	4	1 Ranger	200	SL	60	465	86	36′ 4″	25′ 10″	7′ 8″	193.3	22	11	12	37	19	14.9	14.4	1813	2882	124	SL	95						
	C-82[8]	Packet		CLM		2 P & W R-2800	2000			3000*	192	106′ 5″	75′ 10″	26′ 4″										50000+								
		M-84		CLM	4–5	1 Ranger																											
Funk Aircraft Corp.		B-75L	715	CLM	2	1 Ly	75	SL	10	350	76	35′	20′	6′	169	23	5	7	15	10	8	18	800	1350	112	SL	90						
General Aircraft Corp.		G1-80[9]	742	CLM	2	1 Ly	75	SL	20	400		31′ 5″	22′	8′ 8″	121.3	13.7	25	None	16.6	8.3	11.1	18.0	890	1350	100		80						
Globe Aircraft Corp.		Swift GC-1	753	CLM	2	1 Con C-85	85	SL	19.5	575		29′	20′ 4″	6′ 2″	130	11.32	4.00	5.16	13.53	6.65	12.07	18.45	1030	1569	132	SL	95						
		GC-1A		CLM	2	1 Con	85	SL	26	600		29′ 2″	20′ 4″	6′ 2″											135	SL	95						
						1																											
Gregg Aircraft Mfg. Co.		Rocket A-75		CLM	2	1 Con A-75	75	SL	18	440	70	35′ 11″	22′ 6″	7′ 7″	144	16	5.30	5.62	12.26	10.86	8.03	16.25	734	1302	116	SL	90						
Grumman Aircraft Engr. Corp.	TBF Avenger[10]			CLM	3	1 Wr.	1700			1400		54′ 2″	40′	16′ 5″										12000*	270*	7500						
	F6F-5 Hellcat			CLM	1	1 P & W R-2800	2000			1500		42′ 10″	33′ 7″	13′	275									7000*	380+							
	F7F Tigercat					2																											
	F8F Bearcat																																
Fairchild Aircraft Co.	JRF-6B Goose	G-21A	654	CAM	8	2 P & W	450		220	1000		49′	38′ 4″	12′	375						21.3	8.9	5530	7955	201							
	J4F Widgeon	G-44	734	CAM	4–5	2 Ranger	200	SL	108	775	82	40′	31′ 1″	9′	245						18.3	11.25	3050	4500	164	SL						
		PC-5A	735	CLM	2	1 Warner	165	SL	34	425	84	35′ 7″	23′ 7″	7′ 8″	185	13.02	12.58	10.09	21.2	17.12	14.05	15.75	2015	2600	163							
	C-80	PJC-2	659	CLM	4	1 Warner	145	SL	34	500	84	35′ 8″	23′ 4″	7′ 3″	185	13.02	12.58	10.09	21.2	17.12	14.05	17.94	1700	2600								
Farrow Aircraft Co.				CLM	4	1	200			600		38′												2550								
Harvey Mach. Co. (Aircraft div.)				CLM	4	1	200			600		38′									10.25	12.8	953	1600	150							
Hookaday Aircraft Corp.		Comet		CLM	2	1 Franklin —	130		24	500		33′	22′ 2″		156						21.4	10	3028	4500								
Howard Aircraft Corp.	NH-1(UC-70B)	DGA-15P	717	CLM	5	1 P & W SB	400	SL	120	920	99¾	38′	25′ 9″	8′ 5″	210								1390	2900	112							
		DGA-125	739	OLM	2	1 Warner 50	125	SL	31	300	89–92	34′	26′ 2″	5′ 7″	179.5	19.10	8.55	6.71	15.3	14.30			1525	2200	120							
		DGA-160		OLM	2	1 Kinner R-5	160			300					179.5	19.10	8.55	6.71	15.3	14.30			1103	1650	114	SL						
Interstate Aircraft & Eng. Corp.	L-6	S-1B1	754	CLM	2	1 Franklin	113	SL	20	270	76	35′ 6″	23′ 5″	7′ 4″	173.8	19.35	7.95	8.1	16.06	12.24	9.49	14.6	1000	1700	105	SL						
		Cadet S-1A	737	CLM	2	1 Continental	65	SL	15	375	76	35′ 6″	24′	7′	173.8	19.35	7.45	6.75	13.02	9.8	6.91	19.23	735	1250	109	SL						
		Cadet S-1A	737	CLM	2	1 Continental	85–90	SL	15	300	72	35′ 6″	24′	7′	173.8	19.35	7.45	6.75	13.02	9.8	6.91	19.23	790	1300	116	SL						
		Rocket 140		CLM	3	1 Continental	140			1000*		31′	21′	6′ 1″										2000								
Johnson Aircrafts, Inc.		Rocket 185		CLM		1	185					31′	21′	6′ 1″									2950	4000								
		Rocket Bi-Motor		CLM	6	2 Con or Ly	220			1500*		40′	25′ 10″	8′ 5″									12700	18000+	400+							
Lockheed Aircraft Corp.	P-38[11]	Lightning		CLM	1	2 Allison	1520			750	138	52′	37′ 10″	9′ 10″	327.5	24.1	27.4	21.4	54.	24.5	48	6.1		18000+	400+							
	C-60(R50)	Lodestar	723	CLM	17	2 P & W or Wr.	1200			1540	126	65′ 6″	49′ 10″	11′ 11″	551	35	29.3	34.8	93.6	40.4	33.5	8.8		18500	276							
	C-69	Constellation		CLM	60	4 Wr. Cyclone	2200				182	123′	95′ 2″	23′ 8″	1650	99.6	154	88	347.3	106.8	52.2	9.8		56250	350+							
	PV-1(B-34)	Ventura		CLM	4	2 P & W R-2800	2000	1500		1350	127	65′ 6″	51′ 5″	11′ 11″	551	34.9	29.3	34.8	88.3	40.4	40.9	7.5	19000	30000	300+		250						
	PV-2(B-37)	Harpoon		CLM																													
		Saturn 75		CLM	10–16	2 Wright	525	SL		1600														13500	240								
		Constitution		CLM		4									Post war transport																		
Luscombe Airplane Corp.		Silvaire 8-D	694	CLM	2	1 Continental	75	SL	23	450	72	35′	20′	5′ 11″	140	13	4.9	5.5	13.0	8.75	9.36	17.5	770	1310	115	SL	90						
Glenn L. Martin Co.	B-26G(JM)	Marauder		CLM	7	2 P & W R-2800	2000			1000+	162	71′	58′ 2″	21′ 6″	664	44.7	33.5	33.7	90.8	52.9				35000	328							
	PBM-3D	Mariner		CFM	9–12	2 Wr. Cyclone	1700			3000+	180	118′	80′	27′ 6″	1408	75.4	58.5	37.7	145.3	96.02				56000	250							
	JRM-1			CFM	132	4 Wright 3350	2200			5000+	200	200′	120′ 3″	47′ 11″	3686	172.8	290	103.7	544.8	277.6				145000	200+							
		170C		CFM	100+	4 P & W Major				3500	200	200′	120′ 3″	47′ 11″	3686	172.8	290	103.7	544.8	277.6				165000	200+							
		Leviathan		CFM	100	6																		250000								
Maule Aircraft Corp.		Mercury 202		CLM	30	2 P & W R-2800	2100		600	500	163	80′ 10″	72′ 2″	26′ 8″	765		84	45	115	76	44	8	22235	33500	311	SL	250						
		Mercury N-1		CLM	2	1 Lycoming	75	SL	15	480	72	30′	21′ 8″	6′ 8″	135	14	5.1	6.8	13.5	8.8	8.5	15.3	610	1150	145	SL	90						
		Canard N-6[12]		CLM	4	1 Lycoming	175		30	520	84	32′	18′	6′ 1″	188						13.3	14.3	1470	2500	163	SL	90						
		Mercury N-12		CLM	3	1 Lycoming	90	SL	15	450	72	30	19′ 10″	6′ 3″	133	14	5.6	6.4	13.5	8.8	10.6	15.6	760	1400	150		100						
North American Aviation, Inc.	P-51D&K	Mustang		CLM	1	1 P. Merlin	1600	11800			134	37′ 5″	32′ 4″	12′ 2″	233.19	12.76	12.41	10.39	28:94	13.02	37	5.4	7124	8604	430		380						
	B-25H(PBJ-1J)	Mitchell		CLM	5	2 Wr. R-2600	1700	4500			151	67′ 7″	51′ 3″	16′ 4″	609.8	32.13	57.4	33.6	92	40.04	46.5	8.8	19924	28330	300+		250						
	B-25J	Mitchell		CLM	6	2 Wr. R-2600	1700	4500			151	67′ 7″	53. 6″	16′ 4″	609.8	32.13	57.4	33.6	92.	40.04	44	7.95	19480	27000	300+		250						
	AT-6D(8NJ-5)	Texan		CLM	2	1 P & W Wasp	600	SL	111	750	108	42′	29′	11′ 9″	253.72	11.40	5.33	13.21	28.34	10.88	20	8.70	4103	5245	205		200						
Northrop Aircraft, Inc.	P-61B(FT-1)	Black Widow		CLM	3	2 P & W	2000+				146	66′	49′ 6″	663										26000	350+							
	B-35																																
Piper Aircraft Corp.	L4-H	Grasshopper J3C	691	CLM	2	1 Continental	65	SL	12	220	72	35′ 3″	22′ 3″	6′ 8″	178.5	19.2	4.	6.53	14.65	10.64	6.83	8.8	740	1220	87		300						
	AE-1(Ambulance)	J5C		CLM	2	1 Lycoming	100	SL	20	238	74	35′ 3″	22′ 6″	6′ 10″	179.3	19.2	4.66	6.76	14.66	10.64	7.95	14.27	906	1427	110		300						
		PT-1		CLM	2	1 Franklin	130		40	700		34′	22′ 10″	6′ 6″	164	15.4	5.9	5.8	15.2	12.2	12.2	15.4	1325	2000	150		250						
Republic Aviation Corp.	P-47D-30	Thunderbolt		CLM	1	1 P & W R-2800	2000+		413	1000		40′ 8″	36′ 1″	14′ 2″	300									14000+	420+		255						
		Thunderbolt Amphibian		CAM	3–4	1	175			525		36′	26′ 6″	8′ 7″										14000+	420+		255						
Ryan Aeronautical Co.[13]	PT-22(NR-1)	ST-3		OLM	2	1 Kinner	160	SL	24	325	94	30′ 1″	22′ 5″	7′ 2″	134.2	11.12	4.64	7.75	14.48	11.	13.8	11.6	1307	1860	149	SL	120						
	PT-25	ST-4		OLM	2	1 Lycoming	185	SL	27	378	88	32′ 10″	24′ 4″	6′ 8″	161.2	16.66	5.2	7.83	18.62	13.75	11.1	9.7	1235	1800	149	SL	120						
Spartan Aircraft Co.	C-71	Executive 7W[14]	628	CLM	5	1 P & W SB	400	5000	112	1000	102	39′	26′ 10″	8′	250	22.18	9.74	10.02	21.84	16.80	17.6	11.	2987	4400	212	SL	180						
Spearman Aviation, Inc.		Ariel A		CLM	2	1 Lycoming			20	450		30′	20′ 3″	6′ 6″	132						8.68	17.63	618	1146	115		90						
		B		CLM	2	1 Continental	75		20	430		30′	20′ 3″	6′ 6″	132						9.1	16.	680	1200	125		90						
		C		CLM	2	1 Franklin	80		20	420		30′	20′ 3″	6′ 6″	132						9.1	15.	680	1200	127		90						
Taylorcraft Aviation Corp.	L2-H	D-65		CLM	2	1 Continental																											
	L2-J			CLM	2	1 Lycoming	65	SL	18	375	72	36′	22′	6′ 8″	183.5	20	2.10	8.	13.	11.	6.54	18.4	730	1200	105		90						
	L2-K			CLM	2	1 Franklin																											
		B-12-B[15]		CLM	2	1	75																1275	2250	125							
		15		CLM	4	1	125		38			36′ 6″	23′	7′ 3″	190																	
Timm Aircraft Corp.				CLM	2	1	65																2725		135							
Thought Div., United Aircraft Corp.	N2T-1 Tudor			OLM	2	1 Continental	220		42	340	94	36′	24′ 7″	10′ 8″	184.9	20.76	11.84	11.78	26.12	15.34	14.75	12.4			400+							
	F4U-1D	Excalibur VS-44A		CLM	1	1 P & W R-2800	2000			1500	160	41′	33′ 4″	16′ 1″	260								30200	57500	225							
	TBY-2[16]	Seawolf		CFM	45	4 P & W	1200	SL		3800	151	124′	79′ 3″	24′ 7″	1670									16000*								
Work Research Corp.		Commuter		CLM	3–4	1																	1983	3103	145							
				CLM	4	2 Franklin	114		50	608																							

—Approximate
—Amphibian
—Aluminum alloy
—Biplane
—Closed
—Continental
—Flying Boat

Fl —Floats
Fr —Franklin
Go —Goody

licopter Specifications

Manufacturer	Designation or Model No. (Army or Navy)	Designation or Model No. (Company)	A.T.C. number	Type	Number of seats	Power Plant: Make of engine	Power Plant: Total rated hp. each	Power Plant: At altitude, ft.	Power Plant: Fuel capacity, gal.	Power Plant: Normal range, mi.	Power Plant: Propeller diameter, in.	Performance: Fuel capacity, gal.	Performance: Normal range, mi.	Performance: High speed	Performance: At altitude, ft.	Performance: Cruising speed	Performance: At altitude ft.,	Performance: Climb at sea level	Performance: Service ceiling	Dimensions: Span	Dimensions: Length overall	Dimensions: Height overall	Dimensions: Wing (including ailerons)	Main Rotor Data: Chord	Main Rotor Data: Rotor blade area (total)	Main Rotor Data: Rotor rpm. cruising	Main Rotor Data: Spar construction	Main Rotor Data: Blade covering	Anti-Torque Rotor Data: No. blades	Anti-Torque Rotor Data: Diameter	Anti-Torque Rotor Data: Chord	Anti-Torque Rotor Data: Rotor rpm. (cruising)	Anti-Torque Rotor Data: Spar construction	Anti-Torque Rotor Data: Blade covering	Fuselage: Construction	Fuselage: Covering	Landing Gear: Type	Landing Gear: Shock unit	Number of seats
ft Corp.	L3-C	O-58B		CLM	2	1 Continental	65	SL	12	218	72									35′	21′ 10″	9′ 1″	169															
		Chief		CLM	2	1	65	SL	24	420										36′	20′ 10″		175															
		Champion		CLM	2	1	65	SL	15	270										35′	21′ 6″		170															
		Arrow		CLM	2	1	90	SL	25	500										30′			137															
		Eagle		CLM	4	1																															
Corp.		Trimmer		CAM	3	2 Continental	85	SL	45	250–600	74									35′ 6″	24′ 10″	8′ 7″	163.6															
Aviation Corp.		Langley XNL-1	755	CLM	4	2 Franklin	90	SL	35	350	60									35′	20′ 10″	7′ 1″	171.5															
Corp.	UC-45A Voyager	18		CLM	8	2 P & W	450	SL		1000										47′ 8″	34′ 3″	9′ 5″	347															
	UC-43C Traveler	F17D	689	CLB	5	1 Jacobs L-6	300	SL	77											32′	26′ 1″	8″	296.4															
	AT-10 Wichita			CLM	2	2 Lycoming	295	SL	128	765	99									44′	32′ 2″	10′ 3″	298															
orp.	P-39Q Airacobra	26		CLM	1	1 Allison	1150	12000	104		124.5	34								34′	30′ 2″	9′ 3″	213.2															
	P-59A Airacomet			CLM	1	2 GE I-16 turb.																															
	P-63B Kingcobra			CLM	1	1 Allison V-1710	1500													38′*	32′ *	9′ 8″*	400															
ft Corp.		Cruisair 14-12-3	745	CLM	3	1 Franklin	120	SL	20	400										34′ 2″	23′	6′ 3″	140															
Corp.	B-17G[1]	Flying Fortress 299		CLM	6-10	4 Wright 1820	1200	SL		3000	139									103′ 9″	74′ 9″	19′ 1″	1420	6														
	B-29A[2]	Superfortress 345		CLM	11	4 Wright 3350	2200			3000+	199									141′ 3″	99′	27′ 9″	1750.8	1														
		Stratoliner SA-307B[3]		CLM	41	4 Wright	1200	SL	1800	1500	139									107′ 3″	74′ 2″	19′ 1″	1485.8	6														
		Clipper 314		CMF	89	4 Wright	1600	SL	5400	4900	177									152′	106′	27′ 7″	2867															
		Stratocruiser 377-24		CLM	100	4 radials	3000	SL	7055	3500	199									141′ 3″	110′ 4″	33′ 3″	1750.8	1														
d Mfg. Co.	RB-1(C-93)	Conestoga		CLM		2 P & W	1200			1700										100′	68′*																	
Co.		Callair A	758	CLM	2	1 Lycoming	100	SL	25	342	74									35′ 10″	23′ 7″	7′	181.6	2														
Corp.	AT-17	Bobcat		CLM	4	2 Jacobs L4MB	225	SL	150	550	93									41′ 11″	32′ 9″	10′	295.9	1														
ultee Aircraft	L-5	Sentinel		CLM	2	1 Lycoming	190	SL	25	257	85									34′	24′	7′ 1″	155	1														
	BT-13(SNV)	Valiant		CLM	3	1 Lycoming	290	SL	70	555	102									41′ 11″	29′ 4″	8′ 7″	258.5	2														
	A-35	Vengeance		CLM	2	1 P & W	450	SL	120	516	108									42′	28′ 10″	18′ 4″	239	1														
	B-24M[5](PB4Y)	Liberator		CLM	5-10	1 Wr.	1700	SL		1500+										45′	40′	13′																
	C-87(RY-1)	Liberator-Express		CLM	5	4 P & W	1200	SL		4000*	139									110′	66′ 4″	18′	1048	6														
	PBY-5A(OA-10)	Catalina		CLM	5	2 P & W	1200	SL		4000*	139									110′	66′ 4″	18′	1048	6														
	PB2-Y3	Coronado		CFM	7	4 P & W	1200	SL		2520	145									104′	63′ 10″	18′ 11″	1400															
		Liberator Liner (39)		CLM	56	4 P & W	1200	SL		3500+	150									115′	79′ 3″	27′ 6″	1078															
	B-32	Dominator		CLM		4 P & W	1350	SL		3000+	133									110′	90′	28′ 6″	1048	8														
						4 Wright	2000+																															
		37		CLM		6 pushers														Large post war transport																	
Corp.		Voyager (125)		CLM	3	1 Lycoming	125	SL		470										34′	23′ 6″																	
		LFA Cadet		CLM	2	1 Franklin	80	SL	20	480	70	27′								27′	17′ 8″	5′ 6″	120															
Corp.	P-40N	Warhawk		CLM	1	1 Allison 1710	1395	SL	20	480	70	27′								27′	17′ 8″	5′ 6″	120															
	C-46B(R5C)	Commando		CLM		2 P & W R-2800	2000	SL		1500	161	108′ 1″								76′ 4″	21′ 9″	1360																
		Commando (CW-20E)		CLM	36–42	2 Wr. C-18-B2	2200				175	108′								76′ 4″	21′ 9″	1360																
t Co.	SB2C[6](A-25)	Helldiver		CLM	2	1 Wr.	1700			1200		49′ 9″								36′ 8″	16′ 11″																	
	A-20J&K	Havoc		CLM	3	2 Wr. R-2600	1825		540	1050	125	61′ 4″								48′	18′ 1″	464.1	42															
	A-26B&C	Invader		CLM	3	2 P & W R-2800	2000					70′								51′ 2″																		
	BTD																																			
	C-47 (R4D)	Skytrain (DC-3)		CLM	32	2 P & W	1050	7500	822	2000+	138	95′								64′ 6″	16′ 11″	987	10															
	C-54B(R5D)	Skymaster (DC-4)		CLM	49	4 P & W R-2000	1450		2877	3610	156	117′ 6″								93′ 11″	27′ 7″	1457	82															
		DC-6		CLM	55	4 P & W R-2800	2100		2577	2715	157	117′ 6″								100′ 7″	28′ 5″	1457	84															
		Skybus		CLM	26	2 In Line	700		300	600		86′ 7″								57′ 2″	22′																	
		DC-7		CLM	118	4 P & W Major	3000			4000+		173′ 3″								123′ 4″	43′ 8″																	
t Div.	FM-2[7]			CLM		1 Wr. GR-1820	1350			1000+		38′								29′ 4″	9′ 8″	260																
Research Corp.		Ercoupe	718	CLM	2	1 Continental	65	SL	23	525	72	30′								20′ 9″	5′ 11″	142.6	16															
		FW-5		CLM	4	1 Lycoming	235	SL		700												232																
ne & Aircraft	PT-19A	M62-A		OLM	2	1 Ranger	175	SL	45	430	86	37′								28′	7′ 6″	200	16															
	UC-61K	24R		CLM	4	1 Ranger	200	SL	60	465	86	36′ 4″								25′ 10″	7′ 8″	193.3	22															
	C-82[8]	Packet		CLM		2 P & W R-2800	2000			3000*	192	106′ 5″								75′ 10″	26′ 4″																	
		M-84		CLM	4–5	1 Ranger																															
Corp.		R-75L	715	CLM	2	1 Ly	75	SL	16	350	76	35′								20′	6′	169	23															
t Corp.		G1-80[9]	742	CLM	2	1 Ly	75	SL	20	400		31′ 5″								22′	8′ 8″	121.3	13															
Corp.		Swift GC-1	753	CLM	2	1 Con C-85	85	SL	19 5	575		29′								20′ 4″	6′ 2″	130	11															
		GC-1A		CLM	2	1 Con	85	SL	26	600		29′ 2″								20′ 4″	6′ 2″																	
					4	1																															
Mfg. Co.		Rocket A-75		CLM	2	1 Con A-75	75	SL	18	440	70	35′ 11″								22′ 6″	7′ 7″	144	16															
raft Engr. Corp.	TBF Avenger[10]			CLM	3	1 Wr.	1700			1400		54′ 2″								40′	16′ 5″																	
	F6F-5 Helicat			CLM	1	1 P & W R-2800	2000			1500		42′ 10″								33′ 7″	13′	275																
	F7F Tigercat					2																															
	F8F Bearcat																																				
	JRF-6B Goose	G-21A	654	CAM	8	2 P & W	450		220	1000		49′								38′ 4″	12′	375																
	J4F Widgeon	G-44	734	CAM	4–5	2 Ranger	200	SL	108	775	82	40′								31′ 1″	9′	245																
		PC-5A	735	CLM	2	1 Warner	165	SL	34	425	84	35′ 7″								23′ 7″	7′ 8″	185	13															
	C-80	PJC-2	659	CLM	4	1 Warner	145	SL	34	500	84	35′ 8″								23′ 4″	7′ 3″	185	13															
o. (Aircraft div.)				CLM	4		200			600		38′																									
aft Corp.		Comet		CLM	2	1 Franklin	130		24	500		33′								22′ 2″																	
t Corp.	NH-1(UC-70B)	DGA-15P	717	CLM	5	1 P & W SB	400	SL	120	920	99[3]/4	38′								25′ 9″	8′ 5″	210																
		DGA-125	739	CLM	2	1 Warner 50	125	SL	31	300	89–92	34′								26′ 2″	5′ 7″	179.5	20															
		DGA-160		CLM	2	1 Kinner R-5	160			300												179.5	19															
aft & Eng. Corp.	L-6	S-1B1	754	CLM	2	1 Franklin	113	SL	20	270	76	35′ 6″								23′ 5″	7′ 4″	173.8	19															
		Cadet S-1A	737	CLM	2	1 Continental	65	SL	15	375	76	35′ 6″								24′	7′	173.8	19															
ts, Inc.		Cadet S-1A	737	CLM	2	1 Continental	85–90	SL	15	300	72	35′ 6″								24′	7′	173.8	19															
		Rocket 140		CLM	3	1 Continental	140			1000*		31′								21′	6′ 1″																	
		Rocket 185		CLM		1	185					31′								21′	6′ 1″																	
aft Corp.		Rocket BI-Motor		CLM	6	2 Con or Ly	220			1500*		40′								25′ 10″	8′ 5″																	
	P-38[11]	Lightning		CLM	1	2 Allison	1520			750	138	52′								37′ 10″	9′ 10″	327.5	24															
	C-60(R50)	Lodestar	723	CLM	17	2 P & W or Wr.	1200			1540	126	65′ 6″								49′ 10″	11′ 11″	551	35															
	C-69	Constellation		CLM	60	4 Wr. Cyclone	2200				182	123′								95′ 2″	23′ 8″	1650	99															
	PV-1(B-34)	Ventura		CLM	4	2 P & W R-2800	2000	1500		1350	127	65′ 6″								51′ 5″	11′ 11″	551	34															
	PV-2(B-37)	Harpoon		CLM																																	
		Saturn 75		CLM	10–16	2 Wright	525	SL		1600																											
ane Corp.		Constitution		CLM		4																															
n Co.		Silvaire 8-D	694	CLM	2	1 Continental	75	SL	23	450	72	35′								20′	5′ 11″	140	13															
	B-26G(JM)	Marauder		CLM	7	2 P & W R-2800	2000			1000+	162	71′								58′ 2″	21′ 6″	664	44															
	PBM-3D	Mariner		CFM	9–12	2 Wr. Cyclone	1700			3000+	180	118′								80′	27′ 6″	1408	75															
	JRM-1	Mars		CFM	132	4 Wright 3350	2200			5000+	200	200′								120′ 3″	47′ 11″	3686	172															
		170C		CFM	100+	4 P & W Major				3500	200	200′								120′ 3″	47′ 11″	3686	172															
		Leviathan		CFM	100	6																															
Corp.		Mercury 202		CLM	30	2 P & W R-2800	2100		600	500	163	80′ 10″								72′ 2″	26′ 8″	765																
		Mercury N-1		CLM	2	1 Lycoming	75	SL	15	480	72	30′								21′ 8″	6′ 8″	135	14															
		Canard N-67		CLM	4	1 Lycoming	175		30	520	84	32′								18′	7′ 1″	188																
n Aviation, Inc.	P-51D&K	Mustang		CLM	1	1 Lycoming	90	SL	15	450	72	30								19′ 10″	6′ 3″	133	14															
	B-25H(PBJ-1J)	Mitchell		CLM	5	1 P. Merlin	1600	11800			134	37′ 5″								32′ 4″	12′ 2″	233.19	12															
	B-25J	Mitchell		CLM	6	2 Wr. R-2600	1700	4500			151	67′ 7″								51′ 3″	16′ 4″	609.8	32															
	AT-6D(SNJ-5)	Texan		CLM	2	1 P & W Wasp	600	4500			151	67′ 7″								53′ 6″	16′ 4″	609.8	32															
aft, Inc.	P-61B(FT-1)	Black Widow		CLM	3	2 P & W	2000+	SL	111	750	108	42′								29′	11′ 9″	253.72	11															
	B-35										146	66′								49′ 6″	663																	
Corp.	L4-H	Grasshopper J3C	691	CLM	2	1 Continental	65	SL	12	220	72	35′ 3″								22′ 6″	6′ 8″	178.5	16															
	AE-1(Ambulance)	J5C		CLM	2	1 Lycoming	100	SL	20	238	74	35′ 3″								22′ 6″	6′ 10″	179.3	19															
		PT-1		CLM	2	1 Franklin	130		40	700		34′								22′ 10″	6′ 6″	164	15															
ion Corp.	P-47D-30	Thunderbolt		CLM	1	1 P & W R-2800	2000+		413	1000		40′ 8″								36′ 1″	14′ 2″	300																
		Thunderbolt Amphibian		CAM	3–4	1	175			525		36′								26′ 6″	8′ 7″																	
ical Co.[12]	PT-22(NR-1)	ST-3		OLM	2	1 Kinner	165	SL	24	325	94	30′ 1″								22′ 5″	7′ 2″	134.2	11															
t Co.	PT-25	ST-4		OLM	2	1 Lycoming	185	SL	27	378	88	32′ 10″								24′ 4″	6′ 8″	161.2	16.4															
ion, Inc.	C-71	Executive 7W[14]	628	CLM	5	1 P & W SB	400	5000	112	1000	102	39′								26′ 10″	8′	250	22															
		Ariel A		CLM	2	1 Lycoming			20	450		30′								20′ 3″	6′ 6″	132																
		B		CLM	2	1 Continental	75		20	430		30′								20′ 3″	6′ 6″	132																
ation Corp.	L2-H	D-65		CLM	2	1 Franklin	80		20	420		30′								20′ 3″	6′ 6″	132																
	L2-J			CLM	2	1 Continental																															
	L2-K			CLM	2	1 Lycoming	65	SL	18	375	72	36′								22′	6′ 8″	183.5	20															
		B-12-B[15]		CLM	2	1 Franklin																															
		15		CLM	4	1	75																														
Corp.				CLM	2	1	125					38′																										
United Aircraft	N2T-1 Tudor			CLM	2	1	65													36′ 6″	23′	7′ 3″	190															
	F4U-1D			OLM	2	1 Continental	220		42	340	94	36′								24′ 7″	10′ 8″	184.9	20.7															
		Excalibur VS-44A		CFM	45	1 P & W R-2800	2000			1500	160	41′								33′ 4″	16′ 1″	260																
	TBY-2[16]	Seawolf		CLM	3–4	4 P & W	1200	SL		3800	151	124′								79′ 3″	24′ 7″	1670																
Corp.		Commuter		CLM	4	2 Franklin	114		50	608																											

mate
lan
m alloy

ntal
Boat

Fl —Floats
Fr —Franklin
Go —Goodyear
Hyd —Hydraulic
Id —Inverted
L —Landplane
Lmd —Laminated
Ly —Lycoming
M —Monoplane
Me —Metal
Mech—Mechanical
Mo —Monocoque
O —Open
Pn —Pneumatic
P&W—Pratt & Whitney
S —Steel
Sl —Sea level
Sh —Shinn
Sol —Solid
Sp —Spruce
Spr —Spring
SS —Stainless Steel
T —Tubing
Trs —Truss
W —Wood
Wl —Weld
Wh —Wheel
Wr —Wright

[1] Also built by Douglas
[2] Also built by Bell and built by Douglas and
[3] Being re-built for TW wings, power plants and tail surfaces.
[4] Transport version ba

ation, Oct., 1944, p. 186; Nov., 205; and this issue's Sketch Book gn Detail, p. 193).

ta based on engineering data and unnel test model. Will utilize eathering semi-rigid rotor system, l be equipped for feeder or short stwar service.

perimental model built primarily purposes; larger model to have of more than a ton and range of mately 400 mi. has been designed. otor blades have tubular steel spar od ribs, leading and trailing edges, ric-covered. (Also see Aviation vember, 1943, page 223.)

ntra-rotating rotors mounted on ined cantilever booms extending n sides of fuselage. Main landing heels attach to booms approxi- one-quarter of distance to rotor hubs. Although no anti-torque s utilized, craft has vertical and tal stabilizing surfaces much like n conventional aircraft, with hori- unit set well above fuselage. Pro- delivered to Army Air Forces.

oposed postwar transport on which work has been going forward. ngines provided for safety factor, gn indicates either engine could otors. Operating costs said to be with other aircraft types of com- parable capacity. Empennage gre sembles that on R-1A except tha zontal stabilizer is set lower. Main of landing gear retractable.

[15] Employs two three-blade rotor in tandem. Rotors have rigid without drag or flapping hinges. is by means of cyclic and collectiv change. This model being constru experimental unit. Figure under disc loading" is rotor blade loadin

[16] Contra-rotating rotors moun cantilever booms extending out from fuselage just behind pilot's c ment. A propeller mounted in a of fuselage gives forward speed wh trol wheel is pushed forward; as w pulled back direction of prope reversed to move craft backward. type is under construction.

[17] First helicopter to be put in q production and first to be accep military service.

[18] Tandem seater being manuf by Nash-Kelvinator under license. Kelvinator is reported considering p production of a commercial versio

[19] Prototype under construction. vision made for minor variation in to assist turning in either direction. engine installation for added safety since design calls for maintaining f either engine.

merican Aircraft Specifications

Performance — Dimensions

Height overall	Area (Sq. Ft.)						Weights				Performance							Wings			Landing Gear						Fuselage or Hull
	Wing (including ailerons)	Ailerons (total)	Fin	Rudder	Stabilizer	Elevators (total)	Wing loading (lb. per sq. ft.)	Power loading (lb. per hp.)	Weight empty	Gross weight, lb.	High speed, mph.	At altitude, ft.	Cruising speed, mph.	At altitude, ft.	Stalling speed, mph.	Climb at sea level, ft. per min.	Service ceiling	Spars	Ribs	Covering material	Type	Tread (in.)	Wheel type and size	Brakes (type and make)	Landing gear shock unit (type and make)	Tail unit	
1"	169	15.52	5.51	6.8	13.66	1.54	7.69	20	793	1300	87	SL	79	SL	43	404	10000	W	Wtrs	Fab	Fx	70	6.00x6	Mech	SprOl	Spr	StWlFab
...	175	...	...	...	...	...	7.4	19.2	825	1250	100	...	90	...	38	500	...	...	...	...	Fx	...	...	...	...	...	...
...	170	...	...	...	...	...	7.2	18.8	710	1220	100	...	90	...	38	500	...	...	...	...	Fx	...	...	...	...	Wh	...
...	137	...	...	...	...	...	10.6	...	850	1450	135	...	125	...	48	550	...	Me	Me	Me	Re	...	...	...	...	Wh	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	ReTri	...	...	...	...	...	...
7"	163.6	16.25	9.5	8.75	14.5	11	13.45	12.92	1520	2200	135	SL	115	SL	48	750	12500	WBox	W	Ply	Re	80	6.00x6	...	Ol-Pn	Spr	Ply
1"	171.5	16.66	4.06	3.98	18.8	10.65	15.45	14.70	1738	2650	138	SL	117	SL	60	695	13300	Ply	Ply	Ply	Fx	120	6.50x8	Go	And-Hyd	Wh	Ply
5"	347	...	...	...	...	...	...	...	5025	7500	223	...	194	12000	61	1850	27000	Me	Me	Me	Re	...	...	Hyd	...	ReWh	Me
...	296.4	22.96	6.5	8.71	24.48	16.56	...	...	...	...	...	...	...	...	...	...	...	SolSp	SpPly	Fab	Re	86	7.50x10	Hyd	SprOl	ReWh	WlStFab
9"	298	20.8	15.2	16.14	30.8	26.22	20.1	10.15	4749	6000	200	SL	176	SL	64	1150	19800	SpBox	SpPly	Ply	Re	152	27" sm	Hyd	AirOl	FxWh	Ply
3"	213.2	15.46	7.9	11.	24.1	16.8	35.5	6.58	5523	1496	380+	...	...	...	...	...	35000+	Me	Me	Me	ReTri	136	Main 26x6	Hyd	Warner	...	Me
10"	400	...	...	...	...	...	...	...	...	10000	400+	...	...	...	...	...	40000+	Me	Me	Me	ReTri	...	...	...	...	...	Me
8"*	...	...	...	...	...	...	...	...	6000*	50	400+	...	...	...	...	...	35000+	Me	Me	Me	TriRe	...	...	Hyd	...	...	Me
3"	140	...	...	...	...	...	13.5	15.8	1140	1900	150	SL	130	SL	47	600	12000	Sp	Sp	Ply	Re	...	8.00x4	ShHyd	Bellanca	Sh	ST
1"	1420	69.5	142.9	37.8	203	114.7	38.45	13.75	38200	65000	300+	...	...	...	85	...	35000+	MeTr	Me	Me	Re	253.5	56"	Hyd	Ol	Wh	Me
9"	1750.8	129.2	172.6	65.2	218	115	70+	13.6	70000	130000	300+	...	250	25000	...	...	35000+	Me	Me	Me	ReTri	341.6	Dual 56"	Hyd	Ol	...	MeSemi-Mo
1"	1485.8	69.5	109.3	39.8	230	98.2	...	...	32646	54000	255	15000	225	15000	80	1390	22000	Me	Me	Me	Re	253.5	...	Hyd	Ol	Wh	Me
3"	2867	163	254.4	89.9	329.9	183.2	29.3	13.1	49149	84000	210	SL	188	SL	70	...	...	Me	Me	Me	...	...	...	...	...	...	Me2Deck
3"	1750.8	129.2	172.6	65.2	218	115	...	...	69600	130000	400	...	340	23500	...	2000	30000	Me	Me	Me	ReTri	341.6	Dual 56"	Hyd	Ol	...	Me
...	...	...	...	...	...	...	24.2	...	23400	33800	...	...	165	...	...	...	...	SS	SS	ReTri	...	...	...	...	Hyd	...	SS
...	181.6	21.4	8.6	10	15.8	14.0	8.53	15.5	1050	1550	112	SL	101	SL	45	710	15500	LmdSp	Sp	Fab	Fx	98	Hayes 8.00x4	HayesHyd	SprOl	SprWh	StFab
...	253.9	18.	10.89	14.87	39.22	23.46	19	25	4100	5700	185	SL	165	SL	66	1650	15000	Sp	Sp	Fab	Re	151¼	Hayes7.50x10	Hayes	BenClx	FxWh	StWlFab
1"	155	16.75	9.71	7.05	21.8	15.62	13.3	11.2	1472	2158	129	...	117	...	42.5	975	15800	WBox	W	WFab	Fx	86.43	Hayes 6.00x6	Hyd	SprHyd	StWh	StFab
7"	258.5	22.02	12.82	14.45	25.06	19.94	15.4	14.3	2810	4000	141	...	...	...	59	980	14000	StTrs	Trs	Fab	Fx	113.5	Hayes7.50x10	SprHyd	Hyd	StWh	StFab
4"	239	18.2	8.06	10.56	24.41	19.22	...	...	3345	4360	166	SL	140	...	75	666	17900	Me	Me	Me	Fx	126.5	27" sm.	Hyd	...	StWh	Me
...	...	...	...	...	...	...	...	...	...	...	250+	...	...	...	...	...	20000	Me	Me	Me	Re	136	36" sm.	Go Hyd	Ol	ReWh	Me
...	1048	64.3	123	48.8	140.5	192	50	11	34933	56000+	320+	...	200+	...	79	...	36000	Me	Me	Me	ReTri	307.5	Hayes 56" sm.	Hayes	Bendix	...	Me
...	1048	64.3	123	48.8	140.5	192	50	11	...	...	320+	...	200+	...	79	...	31000	Me	Me	Me	ReTri	307.5	Hayes 56" sm.	Hayes	Bendix	...	Me
11"	1400	...	...	...	...	...	25	14.6	20039	35000	196	...	130	10000	79	...	15800	Me	Me	Me	ReTri	...	...	...	...	...	Me
6"	1078	...	...	...	...	...	38	13.7	39332	66000	200+	...	160	...	75	...	20800	Me	Me	Me	...	...	...	...	...	...	Me
6"	1048	83.2	80.21	56.7	189.2	101.7	16.1	16.	30928	64000	266+	13500	200	10000	90	...	...	Me	Me	Me	ReTri	307.5	Hayes 56" sm.	Hyd	Bendix	...	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Me	Me	Me	ReTri	...	...	...	...	...	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Me	Me	Me	ReTri	...	...	...	...	...	Me
...	...	...	...	...	...	...	...	...	1118	1875	123	SL	112	SL	51.5	750	14000	Sp	Me	Fab	Fx	...	...	...	...	...	StFab
6"	120	9.22	3.77	3.57	12.40	5.26	10.88	16.3	860	1305	140	SL	120	SL	45	800	17500	LmdSp	W	Fab	Re	79	Hayes 5.00x4	Hyd	OlSpr	Wh	Semi Mo
6"	120	9.22	3.77	3.57	12.40	5.26	10.88	17.4	820	1305	140	SL	120	SL	45	800	17500	LmdSp	W	Fab	Re	79	Hayes 5.00x4	Hyd	OlSpr	Wh	SemiMo
7"	...	...	...	...	...	...	38.5	7.32	6590	9000	350+	...	300	...	52	...	30000	Me	Me	Me	Re	...	27"	Hyd	PnOl	ReWh	MeSemiMo
9"	1360	79.2	115.4	52.8	158.5	98.4	33.09	14.06	29438	48000	265+	13000	227	10000	71	...	24500	Me	Me	Me	Re	311	55x19	Hyd	ArOl	ReWh	MeSemiMo
9"	1360	79.2	115.4	52.8	158.5	98.4	33.09	14.06	32100	48000	265+	...	242	10000	71	...	...	Me	Me	Me	Re	311	55x19	Hyd	ArOl	ReWh	MeSemiMo
11"	...	...	...	...	...	...	...	...	...	...	300	...	250	...	...	...	25000	Me	Me	Me	Re	...	...	...	...	FxWh	MeSemiMo
1"	464.1	42.1	25	35.2	60.8	39.7	43.01	7.4	...	20000	350+	...	...	...	98	...	20000	Me	Me	Me	ReTri	203.5	Go 44"	Hyd	PnOl	...	MeSemiMo
...	...	...	...	...	...	...	...	...	...	27500+	350+	...	300+	...	...	...	...	Me	Me	Me	ReTri	...	...	...	...	...	MeSemiMo
11"	987	102.8	47.1	46.3	127.9	82.3	25.3	12.0	16970	29000	230	8500	185	10000	67	1170	24100	Me	Me	Me	Re	222	Bndx 17.00x6	Bendix	Ol	FxWh	Me
7"	1457	85.4	134.3	47.6	238.3	86.6	48.9	12.3	39000	71300	280	25000	239	10000	80	1200	26600	Me	Me	Me	ReTri	296	Go 17.00x20	Hyd	PnOl	...	MeSemiMo
5"	1457	84.1	136.5	49.5	284.9	112.5	55	9.6	...	80500	334	23800	278	...	80	...	...	Me	Me	Me	ReTri	...	...	...	...	...	MeSemiMo
...	...	...	...	...	...	...	...	...	10680	17300	...	...	189	...	65	...	...	Me	Me	Me	ReTri	...	...	...	...	...	Me
8"	...	...	...	...	...	...	...	...	85890	162000	400*	...	300+	...	...	...	...	Me	Me	Me	ReTri	408	...	...	...	...	Me
8"	260	...	...	...	...	...	...	...	...	...	300+	...	...	...	...	...	30000+	Me	Me	Me	Re	...	...	Hyd	...	...	MeSemiMo
11"	142.6	16.8	3.3	6	10.2	9.4	8.8	19.4	725	1260	117	SL	105	SL	48	700	13000	Me	Me	Me-Fab	FxTri	...	Hayes 7.00x4	Hyd	Ol	...	MeMo
...	232	...	...	...	...	...	...	...	1507	2650	180	...	165	...	50	1200	18000	Me	Me	Fab	Re	...	...	...	...	FxWh	...
6"	200	16.72	6.15	14.5	26.77	13.23	12.6	14.4	1851	2518	125	SL	113	SL	52	655	13000	WBox	W-Tr	Ply	Fx	112	6.50x10	Hyd	SprOl	SprOl	StWlFab
8"	193.3	22	11	12	37	19	14.9	14.4	1813	2882	124	SL	112	SL	57	650	12700	Sp	Sp	Fab	Fx	111	6.50x10	Hyd	SprOl	SprOl	StWlFab
4"	...	...	...	...	...	...	...	...	...	50000+	...	...	...	...	...	...	...	Me	Me	Me	ReTri	...	...	Hyd	Ol	...	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Re	...	...	...	...	FxWh	...
...	169	23	5	7	15	10	8	18	800	1350	112	SL	100	SL	37	800	17000	Sp	Sp	Fab	Fx	72	Fire 6.00x6	Firestone	Ol	Hyd, Wh	Fab
8"	121.3	13.7	25	None	16.6	8.3	11.1	18.0	890	1350	100	...	92	...	44	550	...	Al	Al	Fab	FxTri	61	...	Hyd	Ol	...	Me, Fab
2"	130	11.32	4.00	5.16	13.53	6.65	12.07	18.45	1030	1569	135	SL	125	SL	42	700	14200	W	W	W	Re	60	Go 6.00x6	Go	Ol	Solic	Wd
2"	...	...	...	...	...	...	...	...	...	...	135	SL	125	...	42	...	...	...	...	Ply	Re	90	...	...	...	...	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7"	144	16	5.30	5.62	12.26	10.86	8.03	16.25	734	1302	116	SL	110	SL	42	850	15000	Me	Me	Me	FxTri	72	Go 5x 7.00	Hyd Go	Gregg Spr	...	MeSemiMo
5"	...	...	...	...	...	...	...	...	...	12000*	270*	7500	...	...	...	...	20000+	Me	Me	Me	Re	...	...	...	...	...	Me
...	275	...	...	...	...	...	...	...	...	7000*	380+	...	260+	...	85	...	35000	Me	Me	Me	Re	...	...	...	...	ReWh	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	375	...	...	...	...	...	21.3	8.9	5530	7955	201	...	190	...	...	1300	22000	Me	Me	Me	Re	...	...	...	...	ReWh	Me
...	245	...	...	...	...	...	18.3	11.25	3050	4500	164	SL	150	SL	58	1000	15500	Me	Me	Me	Re	90	7.50x10	Hyd	...	ReWh	Me
8"	185	13.02	12.58	10.09	21.2	17.12	14.05	15.75	2015	2600	163	...	145	...	56	700	16000	Me	Me	Me	Re	...	General	...	Ol	StWh	MeSemiMo
3"	185	13.02	12.58	10.09	21.2	17.12	14.05	17.94	1700	2600	...	...	135	...	53	660	15500	Me	Me	Me	Re	...	General	...	Ol	StWh	MeSemiMo
...	156	...	...	...	...	...	10.25	12.8	953	2550	...	...	150	...	40	...	20000	...	...	...	...	...	...	...	...	...	...
5"	210	...	...	...	...	...	21.4	10	3028	1600	150	...	135	...	45	1150	19000	...	...	...	Fx	...	...	...	...	...	StFab
7"	179.5	20.20	8.55	6.71	15.3	14.30	...	...	1390	4500	112	...	192	...	...	1560	21500	Sp	W	PlyFab	Fx	100	8.50x10-6Ply	Go Hyd	...	10"StWh	StWlFab
...	179.5	19.10	8.55	6.71	15.3	14.30	...	...	1525	2200	120	...	102	...	53	725	12500	Sp	Sp	Ply	Fx	113.5	8.00x5	Hyd	SprHyd	StWh	StWlFab
4"	173.8	19.35	7.95	8.1	16.06	12.24	9.49	14.6	1103	1650	114	SL	105	SL	39	900	16500	Sp	Me	Fab	Fx	76	Fire-Sh 7x6	Fire-Sh-Hy	SprOl	Whl	StFab
...	173.8	19.35	7.45	6.75	13.02	9.8	6.91	19.23	735	1250	109	SL	100	SL	39	625	15000	Sp	Me	Fab	Fx	76	Fire-Sh 6x6	Fire-Sh-Hy	SprOl	Wh	StFab
...	173.8	19.35	7.45	6.75	13.02	9.8	6.91	19.23	790	1300	116	SL	108	SL	39	800	16000	Sp	Me	Fab	Fx	76	Fire-Sh 6x6	Fire-Sh-Hy	SprOl	Wh	StFab
1"	...	...	...	...	...	...	...	...	...	2000	...	...	175	...	50	...	...	Wd	Wd	Ply	ReTri	...	...	...	...	...	StWlPlyFab
1"	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Wd	Wd	Ply	ReTri	...	...	...	...	...	StWlPlyFab
5"	...	...	...	...	...	...	...	...	2950	4000	...	...	215	...	50	...	...	Wd	Wd	Ply	ReTri	...	...	...	...	...	StWlPlyFab
10"	327.5	24.1	27.4	21.4	54.	24.5	48	6.1	12700	18000+	400+	...	...	...	90	...	35000+	Me	Me	Me	ReTri	198	Main 36"	Go Hyd	Phol	...	Me
11"	551	35	29.3	34.8	93.6	40.4	33.5	8.8	...	18500	276	...	248	...	70	...	27000	Me	Me	Me	Re	184	Go 42.31x15.6	Go Hyd	Airol	Wh	MeMo
8"	1650	99.6	154	88	347.3	106.8	52.2	9.8	...	86250	350+	...	...	...	80	...	35000	Me	Me	Me	ReTri	...	...	...	...	...	Me
11"	551	34.9	29.3	34.8	88.3	40.4	40.9	7.5	19000	30000	300+	15000	...	...	80	...	30000	Me	Me	Me	Re	184.5	Go 16.00x16	Go Hyd	BndxAirOl	18'	Wh MeMo
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	13500	240	...	200+	...	73	1230	26000	Me	Me	Me	ReTri	...	Dual	...	...	...	Me
ort	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11"	140	13	4.9	5.5	13.0	8.75	9.36	17.5	770	1310	115	SL	109	SL	47	615	14000	Me	Me	Fab	Fx	76	Sh6C SHB	Mech-SH	Ol-Own	StWhl	MeMo
6"	664	44.7	33.5	33.7	90.8	52.9	...	...	...	35000	326	...	...	...	...	...	24000*	Me	Me	Me	ReTri	252	47" sm.	Go Hyd	...	...	...	Me
6"	1408	75.4	58.5	37.7	145.3	96.02	...	...	...	56000	220	...	...	...	...	...	15000+	Me	Me	Me	...	...	...	...	...	...	...	Me
11"	3686	172.8	290.	103.7	544.8	277.6	...	...	...	145000+	200+	...	175+	...	...	...	15000+	Me	Me	Me	...	...	...	...	...	...	...	Me
11"	3686	172.8	290	103.7	544.8	277.6	...	...	...	165000	200+	5000	...	10000	...	657	18700	Me	Me	Me	...	...	...	...	...	...	...	Me
...	...	...	...	...	...	...	...	...	...	250000	...	...	200+	...	...	...	...	Me	Me	Me	...	...	...	...	...	...	...	Me
8"	765	...	84	45	115	76	44	8	22235	33500	311	8500	250	10000	80	1650	28700	Me	Me	Me	ReTri	300	36" Dual	Hyd	...	...	Me
8"	135	14	5.1	6.8	13.5	8.8	8.5	15.3	610	1150	145	SL	130	SL	45	1200	20000	Me	Me	Fab	Fx	84	Fi 6.00x6	Sh Hyd	...	Wh	MeMo
1"	188	...	...	...	...	...	13.3	14.3	1470	2500	155	SL	170	SL	52	1100	20000	Me	Me	MeFab	ReTri	101	Fi 24"	Hyd	Ol	...	MeMo
3"	133	14	5.6	6.4	13.5	8.8	10.6	15.6	760	1400	162	SL	140	SL	50	1400	21000	Me	Me	MeFab	ReTri	90	6.00x6	Sh Hyd	Ol	...	MeMo
2"	233.19	12.76	12.41	10.39	28.94	13.02	37	5.4	7124	8604	450	...	...	...	...	...	40000+	Me	Me	Me	Re	142	Go 27"	Hyd	Bendix	ReWh	Me
4"	609.8	32.13	57.4	33.6	92	40.04	46.5	8.3	19924	28330	300+	13000	...	...	...	...	23800	Me	Me	Me	ReTri	232	47"	Hyd	Bendix	...	Me
4"	609.8	32.13	57.4	33.6	92.	40.04	44	7.95	19480	27000	300+	14500	...	...	...	...	25500	Me	Me	Me	ReTri	232	47"	Hyd	Bendix	...	Me
9"	253.72	11.40	5.33	13.21	28.34	10.88	20	8.70	4103	5245	205	5000	190	SL	72	1750	21500	Me	Me	Me	Re	102¾	27"	Hyd	Bndx-Glad	Wh	Me
3	...	...	...	...	...	...	...	...	...	26000	350+	...	...	...	90	...	...	Me	Me	Me	ReTri	...	Go	Go Hyd	Bendix	...	Me
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8"	178.5	19.2	4.	6.53	14.65	10.64	6.83	8.8	740	1220	87	3000	75	3000	38	450	11500	W	Me	Fab	Fx	71	Hayes 8.00x4	Hyd	Shk cord	SprWh	StWlFab
10"	179.3	19.2	4.66	6.76	14.66	10.64	7.95	14.27	906	1427	110	3000	95	3000	45	600	15000	W	Me	Fab	Fx	74.5	Hayes 8.00x4	Hyd	Shk cord	SprWh	StWlFab
6"	164	15.4	5.9	5.8	15.2	12.2	12.2	15.4	1325	2000	150+	...	135+	...	—50	750.	...	WBox	W	PlyFab	Re	100	...	Hyd	Ol	Wh	StWlFabPly
2"	300	...	...	...	...	...	...	...	...	14000+	430+	25000	300+	...	...	...	35000	Me	Me	Me	Re	187	Bndx 34.00x9	Bendix	AirOl	ReWh	Me
7"	...	...	...	...	...	...	...	...	...	2600	120	...	105	...	50	...	...	Me	Me	Me	Re	...	...	...	...	...	Me
2"	134.2	11.12	4.64	7.75	14.48	11.	13.8	11.6	1307	1860	128	SL	116	SL	54	860	14800	W	Me	Fab	Fx	78¾	Hayes 7.00x6	Mech Hyd	Ol	Wh	Me
8"	161.2	16.66	5.2	7.83	18.62	13.75	11.1	9.7	1235	1800	149	SL	134	SL	54	1590	20300	W	W	Ply	Fx	80	Hayes 7.00x6	Hyd	Ol	Wh	Ply
...	250	22.18	9.74	10.02	21.84	16.80	17.6	11.	2937	4400	212	5000	208	9600	65	1430	24000	StT	Me	Me	Re	126	7.50x10	Go Hyd	AirOl	Wh	Me
6"	132	...	...	...	...	...	8.68	17.63	618	1146	115	...	105	...	40	750	14000	W	W	PlyFab	Fx	...	...	Mech	...	Wh	StWlFab
6"	132	...	...	...	...	...	9.1	16.	680	1200	125	...	110	...	43	930	16000	W	W	PlyFab	Fx	...	...	Mech	...	Wh	StWlFab
6"	132	...	...	...	...	...	9.1	15.	680	1200	127	...	112	...	43	1050	17000	W	W	PlyFab	Fx	...	...	Mech	...	Wh	StWlFab
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8"	183.5	20	2.10	8.	13.	11.	6.54	18.4	730	1200	105	...	95	...	35	630	15000	SolSp	Me	Fab	Fx	72	6.00x6	Mech	Shk cord	Wh	StWlFab
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3"	190	...	...	...	...	...	...	...	1275	2250	125	...	112	...	40	...	...	...	...	Fab	Fx	...	...	...	Hyd	Wh	StWlFab
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Me	Me	Me	...	...	...	...	...	...	Me
8"	184.9	20.76	11.84	11.78	26.12	15.34	14.75	12.4	...	2725	135	...	115	...	54	1000	15000	Lmd Bx	TrsSp	Ply	Fx	107½	Hayes 22"	Hayes	Ol	Wh	Ply
1"	260	...	...	...	...	...	...	...	...	...	400+	...	...	...	90	...	35000+	Me	Me	...	...	...	...	...	...	...	Me
7"	1670	...	...	...	...	...	...	...	30200	57500	225	...	175	10000	...	900	19000	Me	Me	Me	...	...	...	...	...	...	Me
...	...	...	...	...	...	...	...	...	...	16000*	...	...	...	...	...	...	...	Me	Me	Me	...	...	...	...	...	...	Me
...	...	...	...	...	...	...	...	...	1983	3103	145	...	115	...	45	809	...	Me	Me	Me	ReTri	...	...	...	...	...	Ply

built by Douglas and Lockheed.
built by Bell and Martin; to be
by Douglas and Lockheed.
re-built for TWA, using B-17
, power plants, landing gear
all surfaces.
sport version based on B-29.

[5] Being built by Ford.
[6] Also built by Canadian Fairchild as SBF and by Canadian Car and Foundry as SBW.
[7] More powerful version of FM-1, designation for F4F's built by Eastern Aircraft Div. of General Motors.
[8] Also built by North American Aviation at Dallas and Kansas City.
[9] Rights to this model sold to Grand Rapids Industries, which, in turn, sold to Le Mars Mfg. Co., Le Mars, Iowa, which will build it as Sky-coupe. General Aircraft of New Jersey is readying new models.
[10] Now built only by Eastern Aircraft under Navy designation TBM.
[11] Also built by Consolidated Vultee.
[12] Model N-6-A will be amphibian.
[13] Building $40,000,000 of Navy fighters on which all data is restricted.
[14] Improved version of this model as well as twin engine personal plane are projected for postwar program.
[15] Postwar version of B-12.
[16] Being built by Consolidated Vultee.

Manufacturer	General			Power Plant					Dim	
	Designation or Model No.	Type	Number of seats	Make of engine	Total rated hp. each	At altitude, ft.	Fuel capacity, gal.	Normal range, mi.	Span	
Armstrong-Whitworth	Albermarle II Glider Tow	CLM	5	2Bristol Hercules XI	1,560	SL	750+	1,300	77′	5
A. V. Roe & Co., Ltd	Lancaster III Bomber	CLM	7	4Rolls Royce Merlin	1,280	12,250	2,000	3,000*	102′	6
	York I Transport	CLM	24	4Rolls Royce Merlin XX	1,260	SL	2,000	3,000*	102′	7
	Tudor Proposed Transport[1]	CLM	24	4				3,000+		
	Avro XIX Feeder Liner	CLM	8	2A-S Cheetah	375		140	400*	56′ 6″	4
Blackburn Aircraft, Ltd	Blackfish Torpedo Bomber[2]	OLB	3	1Bristol	775			660	45′ 6″	4
Bristol Aeroplane Co., Ltd	Beaufighter X Attack	CLM	2	2Bristol Hercules XVI	1,650	SL	553	1,500	57′ 10″	4
	Proposed Freighter	CLM		2Bristol Perseus	1,000			1,400		
Commonwealth Aircraft Corp	Boomerang Fighter	CLM	1	1P&W Twin Wasp					36′ 3″	2
de Havilland Aircraft Co., Ltd	Mosquito VI Fighter	CLM	2	2Rolls Royce Merlin XXI	1,280		536Br		54′ 2″	4
	Albatross Transport	CLM	34	4DH Gypsy	525	SL	440	1,041	105′	7
Fairey Aviation Co., Ltd	Barracuda Torpedo Bomber	CLM	3	1Rolls Royce Merlin XXXII					49′ 2″	4
	Firefly Recon-Fighter	CLM	2	1Rolls Royce Griffon II	2,200+				44′ 6″	3
Gloster Aircraft Co., Ltd	F.9/37 Fighter	CLM	1	2Bristol Taurus TE/I	1,050				50′	3
	Jet Fighter	CLM	1	1Power Jet (Whittle)						
Handley Page, Ltd	Halifax III Bomber	CLM	6	4Bristol Hercules XVI	1,650			3,000	104′	7
	Hermes Transport	CLM	56	4Bristol Hercules XVI	1,650		2,750Br	2,000	113′	8
Hawker Aircraft, Ltd	Hurricane II B Fighter	CLM	1	1Rolls Royce Merlin XX	1,185	21,000		730	40′	3
	Tornado Fighter	CLM	1	1Rolls Royce Vulture V	2,060		152		41′ 7″	3
	Typhoon Fighter	CLM	1	1 Napier Sabre	2,200			500	41′ 7″	3
	Tempest V Fighter	CLM	1	1 Napier Sabre IIa	2,200				41′	3
Noorduyn, Ltd	Norseman Transport	CLM	8–10	1Pratt & Whitney	550	5,000	125	600	51′ 6″	3
Phillips & Powis, Ltd	Miles M-20 Fighter	CLM	1	1Rolls Royce Merlin XX	1,260	SL				
	Miles M-28 Trainer	CLM	2–3	1DH Gypsy Major III	150	SL		715	30′	2
	Miles X Proposed Transport	CLM	55	8Rolls Royce	1,750	16,000		3,450	150′	11
	Miles M-39B Libelulla	CL	1	2DH Gypsies				Experimental canard typ		
Percival Aircraft, Ltd	Proctor IV Trainer	CLM	3	1DH Gypsy Queen II	210	SL		540	39′ 6″	2
	Proposed Cargo Carrier	CLM		6	2,500			1,600		
Reid & Sigrist	Desford Trainer	CLM	2	2DH Gypsy Major I	130	SL	54	526	34′	2
Short Bros., Ltd	Sunderland III	CFM	10	4Bristol Pegasus XVIII	1,000	SL	1,520	2,880	112′ 9.5″	8
	Shetland Transport	CFM	50-100	4Bristol Centaurus	2,000+			3,000+		
	Stirling IV Cargo Transport	CLM	6–7	4Bristol Hercules XVI	1,650			2,000+	99′ 1″	8
Supermarine Vickers Armstrong, Ltd.	Sea Otter I Reconn-Rescue	CAB	3	1Bristol Mercury XXX	870				46′	3
	Spitfire XI Photo Reconn	CLM	1	1Rolls Royce Merlin LXI	1,650			1,200+	36′ 10″	3
	Spitfire XIV Fighter	CLM	1	1 Rolls Royce Griffin LXV	2,000				36′ 10″	3
	Seafire III Fighter	CLM	1	1 Rolls Royce Merlin LV	1,410				36′ 8″	3
	Warwick Transport	CLM		2P&W Double Wasp	2,000			2,500+	96′ 8.5″	7
Arado Flugzeugwerke GmbH	Ar 232 Bomber-Transport	CLM	4–5	2BMW 801	1,600				105′	7
	Ar 240 Fighter-Bomber	CLM	2	2Mercedes Benz 603	1,700*				49′ 6″	3
Blohm & Voss	Bv 222 Transport	CFM		6BMW 801	1,600				150′ 10″	12
Dornier-Werke GmbH	Do 217E Dive-Torpedo Bomber	CLM	4	2BMW 801 A	1,580				62′ 5″	5
	Do 217J Fighter	CLM	2–3	2BMW 801A	1,580				62′ 5″	5
	Do 217K Bomber	CLM	4	2BMW 802	1,600				80′ 6″	5
	Do 217M Bomber	CLM	4	2Daimler Benz DB603	1,460				62′ 5″	5
Focke-Wulf GmbH	Fw 190A3 Fighter	CLM	1	1BMW 801D	1,600		138	525	34′ 6″	2
	Fw 390 Fighter	CLM	1	1Daimler Benz DB603	1,800*		138	525	34′ 6″	3
	Fw 191 Moskito Fighter	CLM		2Inline		Said to be the Nazi "Answer to the				
	Fw 200K Bomber-Transport	CLM		4BMW 801	1,320		2,112	2,300	108′ 6″	7
Gothaer Waggonfabrik AG	Go 242 Cargo-Transport	CLM	25	2Gnome-Rhone 14N	950				79′	5
E. Heinkel Flugzeugwerke GmbH	He 111Z Glider Tug[3]	CLM		4DB601N and 1BMW801					115*	5
	He 177 Bomber	CLM	6	2DB610	2,460	19,000	2,784		103′ 6″	6
	He 219 Fighter-Bomber	CLM	2	2Daimler Benz 603	1,100				60′ 6″	4
	He 280 Jet Fighter	CLM	1	2Gas Turbine						
Henschel Flugzeugwerke AG	Hs 129 Attack	CLM	1	2Gnome-Rhone 14M	1,680				41′ 6″	3
Junkers Fleuugzeug und Mb. AG	Ju 88-R Fighter	CLM	3	2Junkers Jumo 211F	1,075		1,220		65′ 7″	4
	Ju 188 Bomber	CLM	4	2BMW 802	1,600			800	72′ 6″	4
	Ju 288 Fighter-Bomber	CLM	4	2BMW 801-D	1,600				60′	4
	Ju 90 Transport	CLM	40	4BMW 132-H	330			1,300	114′ 10″	8
	Ju 290 Transport	CLM		4BMW 801	1,600			1,250	123′	9
	Ju 352 Transport	CLM		3Junkers Jumo 211	1,200				110′	7
Messerschmitt AG	Me 109G16 Fighter Bomber	CLM	1	1Daimler Benz DB 605	1,400	18,500	88+	655	32′ 7″	2
	Me 109M Fighter	CLM	1	1Junkers Jumo	2,200					
	Me 163B Fighter	CLM	1	Rocket propulsion unit					30′*	2
	Me 262 Fighter	CLM	1	2Junkers Jumo 004 Turbine					41′	3
	Me 243 Bomber-Transport	CLM		4Daimler Benz DB603	1,700					
	Me 250 Bomber	CLM		4Daimler Benz DB603	1,700					
	Me 323 Transport	CLM	130	6Gnome-Rhone 14N	950			500	181′	9
	Me 210 Fighter	CLM	2	2Daimler Benz DB601F	1,390		550		52′ 9″	4
	Me 410 Fighter	CLM	2	2Daimler Benz DB603	1,700	19,000	506		52′ 9″	4
Siebel Flugzeugwerke AG	Si 204 Trainer-Transport	CLM	10	2Argus As411	440			1,100		
FZG	FZG76 (V-1 Buzzbomb)			1Impulse jet unit	600		130	150	17′ 6″	2
Alf	Reconn	....	Ka	94	CLM		1Kawanishi Hiro						45′ 10″	3
Anne	Bomber	....	M	97	CLM	2–3	1Mitsubishi Kinsei	800			750	39′ 4″	2
Babs 1	Recoan	Ar	M	97	CLM	2	1Nakajima Kotobuki III[2]	550		150	960	39′ 4″	2
Babs 2	Rec-Bomb	Ar	M	97	CLM	2	2Mitsubishi Kinsei	800				39′ 4″	2
Babs 3	Reconn	Ar	M	98	CLM	2	1Mitsubishi Kinsei	800				39′ 4″	2
Betty 11	Bomber	Na	M	01	CLM	7–8	2Mitsubishi Kasei 15	1,050		756	1,800	82′ 4″	6
Betty 22	Bomber	Na	M	01	CLM	7–8	2Mitsubishi	1,800*			2,800	82′ 4″	6
Cherry	Reconn	Na	Ka	99	CFM		2Mitsubishi					77′	5
Claude	Fighter	Na	M	96	OLM	1	1Mitsubishi Kinsei	730	9,000	80	440	36′ 2″	2
Dave	Reconn	Na	N	95	OFlB	2	1Nakajima Kotobuki	650			500	36′ 1″	2
Dick	Fighter	Na			CLM	1	1Air cooled radial	1,000*				36′	2
Dinah 1	Reconn	Ar	M	00	CLM	2	2Mitsubishi	1,060				48′ 3″	3
Dinah 2	Reconn	Ar	M	00	CLM	2	2Nakajima					48′ 3″	3
Dinah 3	Reconn	Ar	M	00	CLM	2	2Mitsubishi	1,000*			1,700	48′ 3″	3
Emily 22	Rec-Bomb	Na	Ka	02	CFM	9	4Mitsubishi Kasei	1,400*			4,000+	124′	9
Frances	Torp-Bomb	Na			CLM	2–3	2Radial						
Frank 1	Fighter	Ar			CLM	1	1Radial	2,000			1,700		
Helen	Bomber	Ar	N	00	CLM	5	2Radial				1,400	66′ 7″	5
Ida	Rec-Bomb	Ar	M	98	CLM		1Mitsubishi Kinsei					39′ 5″	2
Irving 11	Fight-Bomb	Na	N		CLM	2	2Nakajima Sakae 21	1,020			1,900	55′	3
Irving 21	Night-fight	Na	N		CLM	2	2Nakajima Sakae 21	1,020			1,900	55′ 9″	4
Jack 11	Fighter	Na			CLM	1	1Mitsubishi Kasei	1,875			1,100	35′ 5″	3
Jake	Rec-Bomber	Na	W	00	CFlM	2	1 Mitsubishi Kinsei	1,000			1,500	47′ 6″	3
Jill	Torp-Bomb	Na	N	02	CLM	2	1Mitsubishi Kasei 25				2,000	48′ 6″	3
Judy	Rec-Bomb	Na	A	02	CLM	2	1Aichi Atsuta	1,150+			2,100	37′ 10″	3
Kate	Torp-Bomb	Na	N-M	97	CLM	2–3	1Nakajima Sakae	1,000			980	50′ 11″	3
Lily 1	Rec-Bomber	Ar	K	99	CLM	4–5	2Nakajima					57′ 10″	4
Lily 2	Bomber	Ar	K	99	CLM	3	2Kawasaki					57′ 10″	4
Liz	Rec-Bomb	Na			CLM		4Radial					140′	8
Mary	Rec-Bomb	Ar	K	98			1Kawasaki					47′ 7″	3
Mavis	Rec-Bomb	Na	Ka	97	CFM	8–10	4Mitsubishi Kinsei	900	13,000	1,747	3,900	131′ 3″	8
Mike	Fighter	Ar		01	CLM	1	1Mercedes-Benz DB601	1,350				32′ 5″	2
Myrt 11	Reconn	Na			CLM	2–3	1Homare	2,000+			2,600		
Nate	Fighter	Ar	N	97	CLM	1	1Nakajima Hikari	800	13,000	80	460	35′ 7″	2
Nell	Bomber	Na	M	96	CLM	4–7	2Mitsubishi Kinsei	1,060	6,500	498	2,000+	82′	5
Nick 1	Fighter	Ar	K	02	CLM	2	2Mitsubishi	1,100*			1,300	49′ 6″	3
Oscar 1	Fighter	Ar	N	01	CLM	1	1Nakajima	950	15,000	149	1,600	37′ 7″	2
Oscar 2	Fighter	Ar	N	01	CLM	1	1Nakajima	1,150				35′ 7″	2
Paul 11	Reconn	Na			CFLM	2	1Mitsubishi Kinsei					42′	3
Pete	Reconn	Na	S	00	OFLB	2	1Nakajima-Sakae 12	950		139	895	37′	2
Rufe	Fighter	Na	N	02	CFLM	1	1Nakajima Sakae 12	950	13,750	225	895	39′ 5″	3
Sally 1	Bomber	Ar	M	97	CLM	7	2Mitsubishi Kinsei	870	10,000	650	1,200	72′	5
Sally 2	Bomber	Ar	M	97	CLM	5	2Mitsubishi	1,000			1,000	73′	5
Sally 3	Bomber	Ar	M	97	CLM	5	2Mitsubishi					74′ 5″	5
Sonia	Rec-Bomber	Ar	M	99	CLM		1Nakajima					39′ 10″	3
Tess	Transport	A-N	N	00	CLM	30*	2Mitsubishi Kinsei					85′	6
Thelma	Transport	....	T	00	CLM	14	2Radial					65′ 6″	4
Thora	Transport	....	N	97	CLM		2Nakajima Kotabuki					55′ 4″	5
Tojo 1	Fighter	Ar	N	02	CLM	1	1Nakajima	1,450				31′ 10″	2
Tojo 2	Fighter	Ar	N	02	CLM	1	1Nakajima				800	31′ 10″	2
Tony	Fighter	Ar	K	03	CLM	1	1Kawasaki	1,100*			1,900	39′ 4″	2
Topsy	Transport	....	M	00	CLM	15	2Mitsubishi	525	SL		1,170	74′	5
Val 11	Dive Bomb	Na	A	99	CLM	2	1Mitsubishi Kinsei	1,075	6,500	271	875	47′ 8″	3
Zeke 22	Fighter	Na	M	00	CLM	1	1Nakajima Sakae 12	950			895	39′ 4″	2
Zeke 32	Fighter	Na	M	01	CLM	1	1Nakajima Sakae 21	1,020	6,400	228	1,500	36′ 2″	2
Zeke 52	Fighter	Na	M	01	CLM	1	1Nakajima Sakae 21	1,020			1,500	36′ 5″	2

* —Approximate
A —Amphibian
Al —Aluminum alloy
B —Biplane
Box —Box spar
C —Closed
Cy —Cyclone
F —Flying boa
Fab —Fabric
Fl —Floats
Fx —Fixed
Hyd —Hydraulic
In —Inverted
L —Landplane
Lmd —Laminated
M —Monoplane
Me —Metal
Mech—Mechanical
Mo —Monocoque
O —Open
Ol —Oleo
Ply —Plywood
Pn —Pneumatic
P&W—Pratt & Whitney
Re —Retractable
S —Steel
SL —Sea level
Sol —Solid
Sp —Spruce
Spr —Spring
SS —Stainless Steel
T —Tubing
TT —Troop Transport
Trs —Truss
Tri —Tricycle
W —Wood
Wl —Welded
Wh —Wheel
Wr —Wright

[1]Also proposed is Tudor Major, with 68-passenger capacity, range of 3,400 mi.
[2]Fairey Swordfish design.
[3]Two 111's put together by adding special center wing section between fuselages.

Foreign Aircraft Specifications

Dimensions			Weights					Performance							Wings			Fuselage or Hull	Landing Gear			
Span	Length overall	Height overall	Wing (including ailerons)	Wing loading (lb. per sq. ft.)	Power loading (lb. per hp.)	Weight empty	Gross weight, lb.	High speed, mph.	At altitude, ft.	Cruising speed, mph.	At altitude, ft.	Stalling speed, mph.	Climb at sea level, ft. per min.	Service ceiling	Spars	Ribs	Covering material		Tail unit	Type	Tread (in.)	Wheel type and size
BRITISH AIRCRAFT																						
77′	50′ 11″	15′ 7″	803.5	.....	.....	22,600	36,500	250+	10,500	.....	.....	.....	.....	.....	WBox	Me-W	Ply	STPly	.....	ReTri	.....	.....
102′	69′ 4″	20′	1,297	.....	.....	.....	60,000	275	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Wh	Re	285	.....
102′	78′	18′ 6″	1,297	50.11	12.89	33,200	65,000	280	.....	233	15,000	.....	820	22,500	Me	Me	Me	Me	Wh	Re	285	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	Re	.....	.....
56′ 6″	42′ 3″	13′ 1″	410	.....	.....	.....	9,500	190	.....	150	.....	.....	.....	.....	WBox	Me-W	Ply	MePlyFab	Wh	Re	.....	.....
45′ 6″	40′ 11″	14′ 7″	542	.....	.....	4,500	7,720	140	7,000	120	.....	.....	1,220	19,250	Me	Me	Fab	MeFab	.....	Fx	.....	.....
57′ 10″	41′ 4″	15′ 10″	451	46.56	6.44	13,800	21,101	352	.....	200+	.....	.....	1,850	28,900	Me	Me	Me	Me	Re Wh	Re	.....	.....
.....	.....	.....	.....	.....	.....	17,500	27,500	.....	.....	120–150	.....	.....	.....	.....	Me	Me	Me	Me	.....	Fx	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Wh	Re	.....	.....
36′ 3″	25′ 6″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
54′ 2″	41′ 2″	15′ 3″	440	.....	.....	.....	18,450	400+	.....	.....	.....	100+	.....	.....	W	W	Ply	Ply	Re Wh	Re	.....	15.00x18 Hyd
105′	71′ 6″	22′ 3″	1,078	27.4	13.9	21,230	29,500	234	8,750	210	11,000	70	1,018	17,900	SpBox	SpPly	Ply	PlyMo	Fx Wh	Re	204	.....
49′ 2″	40′ 6″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx Wh	Re	.....	.....
44′ 6″	37′ 7″	13′ 7″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
50′	37′	11′ 7″	386	30.1	6.5	8,828	11,615	360	15,000	.....	.....	.....	2,030	30,000	Me	Me	Me	Me	Re Wh	Re	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	ReTri	.....	.....
104′	70′ 1″	20′ 9″	.....	.....	.....	36,000+	60,000+	300*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
113′	81′ 8″	31′	.....	.....	.....	.....	70,000	340	.....	240	10,000	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
40′	32′ 3″	13′ 3″	257.6	28.9	6.23	5,590	7,440	340	21,500	213	.....	.....	2,950	40,000	Me	Me	Me	StTFab	Fx Wh	Re	94	.....
41′ 7″	32′ 6″	16′	280	.....	.....	8,200	1,030	425	23,000	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
41′ 7″	31′ 11″	15′ 3″	276	.....	.....	.....	.....	400+	.....	.....	.....	105	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
41′	33′ 8″	16′ 1″	302	.....	.....	.....	.....	425+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
51′ 6″	32′	10′ 3″	325	22.8	12.3	3,816	6,450	170	5,000	150	5,000	55	.....	22,000	Sp	Sp	Fab	StTFab	Fx Wh	Fx	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	340+	.....	.....	.....	.....	.....	.....	W	W	W	W	Fx Wh	Fx	.....	.....
30′	23′ 8″	8′	.....	.....	.....	1,460	2,028	160	SL	150	3,000	40	1,250	.....	W	W	Ply	W	Fx Wh	Re	.....	.....
150′	110′	.....	2,350	55.2	8.96	65,000	130,000	425	16,000	350	16,000	.....	1,500	.....	Me	Me	Me	Me	.....	ReTri	.....	.....
al canard type																				ReTri	.....	.....
39′ 6″	28′ 1.5″	7′ 6″	202	17.3	16.8	2,370	3,500	160	SL	140	.....	55	700	14,000	W	W	PlyFab	SpPly	Fx Wh	Fx	9′ 9″	.....
.....	.....	.....	.....	.....	.....	.....	150,000	328	.....	269	.....	83*	.....	.....	W	W	W	W	.....	ReTri	.....	.....
34′	25′ 6″	7′ 9″	186	16	11.5	1,905	3,000	165	.....	150	.....	58	1,450	16,750	Sp	Sp	Ply	Ply	Fx Wh	Fx	.....	.....
112′ 9.5″	87′ 4″	32′ 1″	1,487	.....	.....	.....	48,500	210	6,250	.....	.....	78	1,200	20,500	Me	Me	Me	Me	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	200,000	300+	.....	275	.....	.....	.....	.....	Me	Me	Me	Me	.....	.....	.....	.....
99′ 1″	87′ 3″	22′ 9″	1,460	.....	.....	46,000	70,000	280–	.....	200	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
46′	39′ 4″	16′ 2″	610	.....	.....	.....	10,000*	.....	.....	.....	.....	.....	.....	.....	Me	W	Fab	Me	St Wh	Re	.....	.....
36′ 10″	31′	11′ 8″	248.5	.....	.....	.....	.....	400+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
36′ 10″	32′ 7.75″	11′ 1.5″	242	.....	.....	.....	8,000*	400+	.....	.....	.....	.....	.....	40,000+	Me	Me	Me	Me	Re Wh	Re	.....	.....
36′ 8″	30′	8′	242	.....	.....	.....	8,000*	370+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Wh	Re	.....	.....
96′ 8.5″	70′ 6″	8′ 6″	1,006	45	12.16	.....	45,000	.....	.....	.....	.....	.....	.....	.....	Me	Me	Fab	MeFab	Re Wh	Re	.....	.....
GERMAN AIRCRAFT																						
105′	78′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Wh	Re	.....	.....
49′ 6″	39′ 9″	.....	.....	.....	.....	.....	.....	325+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
150′ 10″	121′	41*	2,655	.....	.....	.....	100,000+	200+	9,840	150*	.....	.....	.....	.....	Me	Me	Me	Me	.....	.....	.....	.....
62′ 5″	56′ 6″	15′ 9″	610	54.9	10.6	.....	33,500	325*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
62′ 5″	58′	15′ 9″	610	.....	.....	.....	.....	325+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
80′ 6″	56′ 6″	.....	.....	.....	.....	.....	.....	302*	.....	.....	Used to launch rocket bombs	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
62′ 5″	56′ 6″	16′ 8.5″	610	.....	.....	.....	35,100*	315*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
34′ 6″	29′ 1″	12″	203	41.7	5.36	7,500	8,600	390	20,000	275	.....	80	3,000	38,000+	Me	Me	Me	Me	Re Wh	Re	.....	7.00x75 Hyd
34′ 6″	32′	12″	203	.....	.....	.....	.....	400+	.....	300*	.....	80	.....	38,000+	Me	Me	Me	Me	Re Wh	Re	.....	7.00x75 Hyd
Answer to the Mosquito"																						
108′ 6″	78′ 3″	23′ 4″	1,290	34.2	8.3	28,700	44,100	279	18,100	224	.....	.....	850	28,850	Me	Me	Me	MeMo	Re Wh	Re	.....	..... Hyd
79′	52′ 9″	11′ 8″	.....	.....	.....	3,200	8,500	.....	.....	.....	.....	.....	.....	.....	W	W	PlyFab	StW	.....	Tri	.....	.....
115*	53′ 7	15′ 9″	1,500*	.....	.....	33,000*	47,000*	285*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	..... Hyd
103′ 6″	67′	21′ 11″	1,095	.....	.....	35,200	68,000	285	20,000	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
60′ 6″	48′ 8″	17′*	480*	.....	.....	.....	.....	370	.....	310	.....	.....	.....	36,000	Me	Me	Me	Me	.....	ReTri	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	.....	.....	.....
41′ 6″	32′ 1″	11′	312	.....	.....	9,250	11,240	270*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx Wh	Re	.....	..... Hyd
65′ 7″	47′ 1″	15′ 5″	515	.....	.....	16,800*	24,000	285	16,000	.....	.....	.....	.....	24,000	Me	Me	Me	Me	Re Wh	Re	.....	..... Hyd
72′ 6″	49′	.....	.....	.....	.....	.....	.....	290	20,000	250*	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
60′	47′	15′ 5″	584	.....	.....	.....	.....	310*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
114′ 10″	86′ 3″	24′ 9″	1,980	25.6	15.25	35,200	50,600	236	3,600	198	9,800	.....	.....	18,040	Me	Me	Me	Me	Re Wh	Re	.....	.....
123′	92′	22′ 6″	2,210	.....	.....	.....	55,000	260*	13,000	185	.....	.....	.....	20,000	Me	Me	Me	Me	Re Wh	Re	.....	.....
110′	78′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Wh	Re	.....	.....
32′ 7″	29′ 8″	7′ 6″	173	35.2	5.6	.....	7,706	395	22,000	306	18,000	.....	.....	41,000+	Me	Me	Me	Me	Fx Wh	Re	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Wh	Re	.....	.....
30′*	20′*	.....	.....	.....	.....	.....	.....	500*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	WhJ't'n	.....	.....
41′	35′ 5″	.....	.....	.....	.....	.....	.....	500+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	Re	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
181′	93′ 4″	24′	2,700	.....	16.9	34,000	65,000	170	SL	110	SL	.....	.....	.....	Me	Me	Fab	StTFab	.....	Fx	.....	.....
52′ 9″	40′ 3″	.....	355	60	7.63	.....	21,350	371	18,000	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
52′ 9″	40′ 10″	.....	390	.....	.....	.....	25,350	395	22,000	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
.....	.....	.....	.....	.....	.....	8,598	12,345	225	.....	210	.....	.....	.....	24,600	Me	Me	Me	Me	Wh	Re	.....	.....
17′ 6″	26′	5′	51	.....	.....	1,800	4,700	350	.....	.....	.....	150*	.....	5,000	Me	Me	Me	Me	None	None	.....	.....
JAPANESE AIRCRAFT																						
45′ 10″	38′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
39′ 4″	27′ 11″	11′ 6″	258	.....	.....	.....	5,060	310	10,000	210	.....	.....	.....	27,000	Me	Me	Me	Me	.....	Fx	.....	.....
39′ 4″	27′	11′ 4″	258	19.0	10.4	.....	5,750	260	15,000	220	.....	.....	.....	.....	Me	Me	Me	Me	Fx	Fx	.....	.....
39′ 4″	27′ 11″	11′ 6″	258	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx	Fx	.....	.....
39′ 4″	27′ 11″	11′ 6″	258	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx	Fx	.....	.....
82′ 4″	65′	19′+	.....	.....	.....	14,722	20,442	288	13,000	.....	.....	.....	1,200	30,000	Me	Me	Me	Me	Fx Wh	Re	.....	.....
82′ 4″	65′ 9″	19′+	.....	.....	.....	17,000	.....	330*	.....	205	.....	.....	1,200	.....	Me	Me	Me	Me	Fx Wh	Re	.....	.....
77′	54′ 7″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	.....	.....	.....
36′ 2″	27′ 4″	.....	170	25.3	5.9	.....	4,300	250	9,000	217	.....	.....	.....	20,000	Me	Me	Me	.....	Fx Wh	Fx	.....	.....
36′ 1″	27′ 10″	13′ 2″	.....	.....	.....	3,800	5,800	160*	11,000	135	.....	.....	900	18,000	.....	.....	Fab	MeFab	.....	.....	.....	.....
36′	26′ 10″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	Re	.....	.....
48′ 3″	36′ 1″	.....	.....	.....	.....	.....	.....	325*	17,000	.....	.....	.....	3,000+	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
48′ 3″	36′ 1″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Me	.....	.....
48′ 3″	36′ 1″	.....	.....	.....	.....	8,000	.....	395	.....	.....	.....	.....	2,700	.....	Me	Me	Me	Me	Re Wh	Me	.....	.....
124′	92′ 6″	30′ 4″	.....	.....	.....	34,000	68,000	296	.....	.....	.....	.....	1,200	.....	Me	Me	Me	Me	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	400+	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	.....	.....	.....	.....
66′ 7″	53′	.....	.....	.....	.....	.....	.....	275*	.....	.....	.....	.....	.....	30,000+	Me	Me	Me	Me	Fx Wh	Re	.....	.....
39′ 5″	26′ 10″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Fx Wh	Fx	.....	.....
55′	38′ 6″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
55′ 9″	40′	15′	.....	.....	.....	10,000*	.....	330	.....	.....	.....	.....	1,700	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
35′ 5″	31′ 10″	.....	.....	.....	.....	.....	.....	400+	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
47′ 6″	35′ 4″	.....	.....	.....	.....	5,800	.....	216	7,500	.....	.....	.....	1,300	24,400	Me	Me	Me	Me	.....	Fl	.....	.....
48′ 6″	35′	.....	.....	.....	.....	.....	10,000	325+	.....	.....	.....	.....	.....	35,000	Me	Me	Me	Me	Re Wh	Re	.....	.....
37′ 10″	33′ 7″	.....	.....	.....	.....	.....	.....	325*	.....	.....	.....	.....	.....	30,000	Me	Me	Me	Me	Re Wh	Re	.....	.....
50′ 11″	33′ 9″	13′ 6″	.....	.....	.....	4,800*	7,200+	230	10,000	190	.....	.....	1,100	24,000	Me	Me	Me	Me	Fx Wh	Re	.....	.....
57′ 10″	41′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
57′ 10″	41′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
140′	85′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	ReTri	.....	.....
147′ 7″	38′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
131′ 3″	84′	20′ 6″	1,400	.....	.....	25,000	44,092	220	13,000	165	6,000	.....	1,000	26,000	Me	Me	Me	Me	.....	.....	.....	.....
32′ 5″	29′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Wh	Re	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	375*	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
35′ 7″	24′ 4″	8′	170	.....	.....	3,250	4,400	280+	13,000	230	.....	.....	.....	33,000	Me	Me	Me	Me	Fx Wh	Fx	.....	.....
82′	54′	12′ 6″	750	.....	.....	12,500	18,500	225+	7,000	190	10,000	.....	1,100	25,000*	Me	Me	Me	Me	Fx Wh	Re	.....	.....
49′ 6″	34′ 5″	.....	.....	.....	.....	8,350	.....	350*	17,000	2,400	.....	.....	.....	35,000+	Me	Me	Me	.....	Re Wh	Re	.....	.....
37′ 7″	29′ 2″	9′	233	.....	.....	3,385	4,785	315+	15,000	.....	.....	.....	2,900	35,000	Me	Me	Me	Me	Fx Wh	Re	.....	.....
35′ 7″	29′ 2″	.....	233	.....	.....	4,100	.....	350*	.....	.....	.....	.....	3,300	.....	Me	Me	Me	Me	Fx Wh	Re	.....	.....
42′	35′ 7″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	Fl	.....	.....
37′	26′	12′ 6″	.....	.....	.....	4,192	5,623	280	16,000	.....	.....	.....	.....	26,000	.....	.....	.....	.....	.....	Fl	.....	.....
39′ 5″	33′ 2″	14′	248	25.4	.....	4,145	5,920	279	15,200	.....	.....	.....	2,200	36,500	Me	Me	Me	Me	.....	Fl	.....	.....
72′	52′	12′	675	.....	.....	.....	.....	230	10,000	212	10,000	.....	.....	22,000	Me	Me	Me	Me	Fx Wh	Re	.....	.....
73′	52′	12′	.....	.....	.....	.....	20,500	264	13,000	.....	.....	.....	.....	23,500	Me	Me	Me	Me	Fx Wh	Re	.....	.....
74′ 5″	52′	12′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx Wh	Re	.....	.....
39′ 10″	30′ 2″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx Wh	FxWh	.....	.....
85′	62′	16′ 4″	939	.....	.....	Douglas DC-2 Design		.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx Wh	Re	.....	.....
65′ 6″	44′ 3″	11′ 6″	551	.....	.....	Lockheed 14 Design		.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	Fx Wh	Re	.....	.....
65′ 4″	50′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Me	.....	Re	.....	.....
31′ 10″	29′ 3″	.....	.....	.....	.....	.....	.....	370+	.....	.....	.....	.....	3,900	.....	Me	Me	Me	Me	.....	Re	.....	.....
31′ 10″	29′ 3″	.....	.....	.....	.....	4,300	.....	375*	.....	.....	.....	.....	3,900	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
39′ 4″	28′ 9″	.....	.....	.....	.....	5,000	.....	360*	.....	.....	.....	.....	2,400	.....	Me	Me	Me	Me	Re Wh	Re	.....	.....
74′	52′ 8″	16′ 2″	755	24.2	8.8	11,900	18,300	266	10,500	197	9,000	75	.....	23,000	Me	Me	Me	Me	Fx Wh	Re	.....	.....
47′ 8″	32′ 11″	.....	390	.....	.....	5,900	8,070	236	6,200	.....	.....	.....	1,600	23,000	Me	Me	Me	Me	Fx Wh	Fx	.....	.....
39′ 4″	29′ 9″	9′ 2″	248	20.2	.....	3,718	5,140	326	16,000	.....	.....	70	3,000+	38,500	Me	Me	Me	Me	Re Wh	Re	.....	.....
36′ 2″	29′ 9″	9′ 2″	232	24.2	.....	3,913	5,570	350	17,000	.....	.....	65	3,000+	40,200	Me	Me	Me	Me	Re Wh	Re	.....	.....
36′ 5″	29′ 9″	9′ 2″	.....	.....	.....	4,100	.....	350+	.....	3,000*	.....	65	3,000+	40,000+	Me	Me	Me	Me	Re Wh	Re	.....	.....

Aircraft Specifications

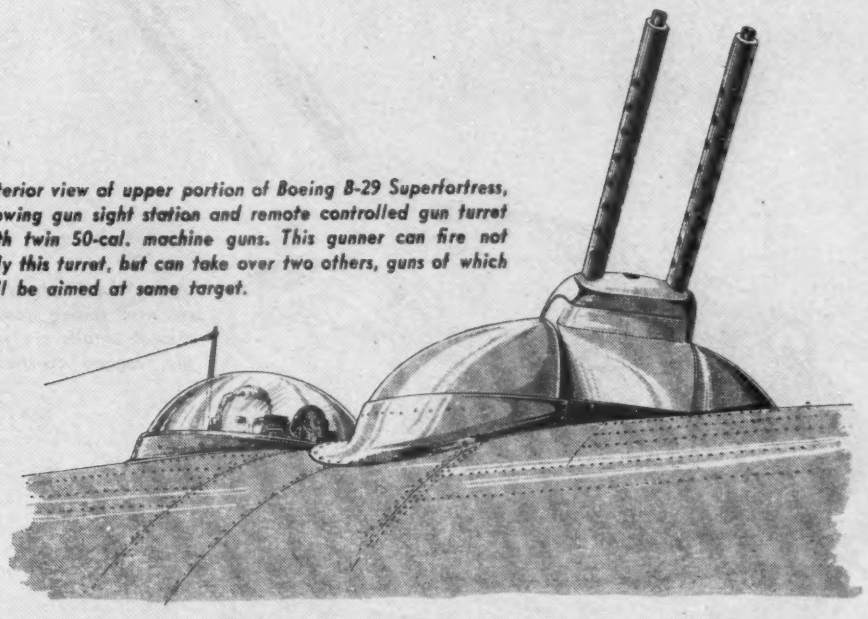
Wing (including ailerons)	Weights: Wing loading (lb. per sq. ft.)	Weights: Power loading (lb. per hp.)	Weights: Weight empty	Weights: Gross weight, lb.	Performance: High speed, mph.	Performance: At altitude, ft.	Performance: Cruising speed, mph.	Performance: At altitude, ft.	Performance: Stalling speed, mph.	Performance: Climb at sea level, ft. per min.	Performance: Service ceiling	Wings: Spars	Wings: Ribs	Wings: Covering material	Fuselage or Hull	Landing Gear: Tail unit	Landing Gear: Type	Landing Gear: Tread (in.)	Landing Gear: Wheel type and size	Landing Gear: Brakes (type and make)	Landing Gear: Landing gear shock struts (type and make)
AIRCRAFT																					
303.5			22,600	36,500	250+	10,500						WBox	Me-W	Ply	STPly		ReTri				
297				60,000	275							Me	Me	Me	Me	Wh	Re	285			
297	50.11	12.89	33,200	65,000	280		233	15,000		820	22,500	Me	Me	Me	Me	Wh	Re	285			
												Me	Me	Me	Me		Re				
410				9,500	190		150					WBox	Me-W	Ply	MePlyFab	Wh	Re				
342			4,500	7,720	140	7,000	120			1,220	19,250	Me	Me	Fab	MeFab		Fx				Hyd
451	46.56	6.44	13,800	21,101	352		200+			1,850	28,900	Me	Me	Me	Me	Re Wh	Re			Dunlop	
			17,500	27,500			120–150					Me	Me	Me	Me		Fx				Pnol
												Me	Me	Me	Me	Wh	Re				
440			18,450		400+				100+			W	W	Ply	Ply	Re Wh	Re		15.00x16	Hyd	
078	27.4	13.9	21,230	29,500	234	8,750	210	11,000	70	1,018	17,900	Sp Box	Sp Ply	Ply	Ply Mo	Fx Wh	Re	204		Dunlop	Rubber
												Me	Me	Me	Me	Fx Wh	Re				
886	30.1	6.5	8,828	11,615	360	15,000				2,030	30,000	Me	Me	Me	Me	Re Wh	Re				Fairey Oi
												Me	Me	Me	Me	Re Wh	Re				
			36,000+	60,000+	300*							Me	Me	Me	Me		ReTri				
				70,000	340		240	10,000				Me	Me	Me	Me	Re Wh	Re				Hyd
257.6	28.9	6.23	5,590	7,440	340	21,500	213			2,950	40,000	Me	Me	Me	StTFab	Re Wh	Re				
280			8,200	1,030	425	23,000						Me	Me	Me	Me	Fx Wh	Re	94		Dunlop Hyd	Vickers
276					400+				105			Me	Me	Me	Me	Re Wh	Re				
302					425+							Me	Me	Me	Me	Re Wh	Re				
325	22.8	12.3	3,816	6,450	170	5,000	150	5,000	55		22,000	Sp	Sp	Fab	StTFab	Re Wh	Fx				
					340+							W	W	W	W	Fx Wh	Fx				Oi
			1,460	2,028	160	SL	150	3,000	40	1,250		W	W	Ply	W	Fx Wh	Re				
350	55.2	8.96	65,000	130,000	425	16,000	350	16,000		1,500		Me	Me	Me	Me		ReTri			Bendix	Oi
																	ReTri				
202	17.3	16.8	2,370	3,500	160	SL	140		55	700	14,000	W	W	PlyFab	SpPly	Fx Wh	Fx	9' 9"		Bendix	Hydspr
				150,000	328		269		83*			W	W	W	W		ReTri				
186	16	11.5	1,905	3,000	165		150		58	1,450	16,750	Sp	Sp	Ply	Ply	Fx Wh	Fx			Dunlop	Lockheed
487				48,500	210	6,250			78	1,200	20,500	Me	Me	Me	Me						
				200,000	300+		275					Me	Me	Me	Me						
460			46,000	70,000	280–		200					Me	Me	Me	Me	Re Wh	Re				Hyd
510				10,000*								Me	W	Fab	Me	St Wh	Re				Hyd
248.5					400+							Me	Me	Me	Me	Re Wh	Re				Hyd
242				8,000*	400+						40,000+	Me	Me	Me	Me	Re Wh	Re				Vickers Oi
242				8,000*	370+							Me	Me	Me	Me	Wh	Re				Vickers Oi
306	45	12.16		45,000								Me	Me	Fab	MeFab	Re Wh	Re			Vickers	Vickers Oi
I AIRCRAFT																					
					325+							Me	Me	Me	Me	Wh	Re				
555				100,000+	200+	9,840	150*					Me	Me	Me	Me	Re Wh	Re				
310	54.9	10.6		33,500	325*							Me	Me	Me	Me	Re Wh	Re				
310					325+							Me	Me	Me	Me	Re Wh	Re				
					302*		Used to launch rocket bombs					Me	Me	Me	Me	Re Wh	Re				
310				35,100*	315*							Me	Me	Me	Me	Re Wh	Re				
203	41.7	5.36	7,500	8,600	390	20,000	275		80	3,000	38,000+	Me	Me	Me	Me	Re Wh	Re		7.00x75	Hyd	Hyd
203					400+		300*		80		38,000+	Me	Me	Me	Me	Re Wh	Re		7.00x75	Hyd	Hyd
290	34.2	8.3	28,700	44,100	279	18,100	224			850	28,850	Me	Me	Me	MeMo	Re Wh	Re			Hyd	Hyd
			3,200	8,500								W	W	PlyFab	StW		Tri				
300*			33,000*	47,000*	285*							Me	Me	Me	Me	Re Wh	Re			Hyd	Hyd
295			35,200	68,000	285	20,000						Me	Me	Me	Me	Re Wh	Re				
280*					370		310				36,000	Me	Me	Me	Me		ReTri				
												Me	Me	Me	Me						
312			9,250	11,240	270*							Me	Me	Me	Me	Fx Wh	Re			Hyd	Hyd
315			16,800*	24,000	285	16,000					24,000	Me	Me	Me	Me	Re Wh	Re			Hyd	Hyd
					290	20,000	250*					Me	Me	Me	Me	Re Wh	Re				
284					310*							Me	Me	Me	Me	Re Wh	Re				
280	25.6	15.25	35,200	50,600	236	3,600	198	9,800			18,040	Me	Me	Me	Me	Re Wh	Re				
210				55,000	260*	13,000	185				20,000	Me	Me	Me	Me	Re Wh	Re				
															Me	Wh	Re				
173	35.2	5.6		7,706	395	22,000	306	18,000			41,000+	Me	Me	Me	Me	Fx Wh	Re				
												Me	Me	Me	Me	Wh	Re				
					500*							Me	Me	Me	Me	Re Wh	Wh J't'n				
					500+							Me	Me	Me	Me		Re				
700		16.9	34,000	65,000	170	SL	110	SL				Me	Me	Me	Me						
355	60	7.63		21,350	371	18,000						Me	Me	Fab	StTFab		Fx				
390				25,350	395	22,000						Me	Me	Me	Me	Re Wh	Re				
			8,598	12,345	325		210				24,600	Me	Me	Me	Me	Re Wh	Re				
51			1,800	4,700	350				150*		5,000	Me	Me	Me	Me	Wh	Re				
																None	None				
E AIRCRAFT																					
258				5,060	310	10,000	210				27,000	Me	Me	Me	Me		Fx				
258	19.0	10.4		5,750	260	15,000	220					Me	Me	Me	Me	Fx	Fx				
258												Me	Me	Me	Me	Fx	Fx				
258												Me	Me	Me	Me	Fx	Fx				
			14,722	20,442	288	13,000				1,200	30,000	Me	Me	Me	Me	Fx Wh	Re				
			17,000		330*		205			1,200		Me	Me	Me	Me	Fx Wh	Re				
												Me	Me	Me	Me						
170	25.3	5.9		4,300	250	9,000	217				20,000	Me	Me			Fx Wh	Fx				
			3,800	5,800	160*	11,000	135			900	18,000			Fab	MeFab						
												Me	Me	Me	Me		Re				
					325*	17,000				3,000+		Me	Me	Me	Me	Re Wh	Re				
												Me	Me	Me	Me	Re Wh	Me				
			8,000		395					2,700		Me	Me	Me	Me	Re Wh	Me				
			34,000	68,000	296					1,200		Me	Me	Me	Me						
					400+																
					275*						30,000+	Me	Me	Me	Me						
																Fx Wh	Re				
												Me	Me	Me	Me	Fx Wh	Fx				
			10,000*		330					1,700		Me	Me	Me	Me	Re Wh	Re				
					400+							Me	Me	Me	Me	Re Wh	Re				
			5,800		216	7,500				1,300	24,400	Me	Me	Me	Me		Fl				
				10,000	325+						35,000	Me	Me	Me	Me	Re Wh	Re				
					325*						30,000	Me	Me	Me	Me	Re Wh	Re				
			4,800*	7,200+	230	10,000	190			1,100	24,000	Me	Me	Me	Me	Fx Wh	Re				
												Me	Me	Me	Me	Re Wh	Re				
												Me	Me	Me	Me	Re Wh	Re				
												Me	Me	Me	Me		ReTri				
400			25,000	44,092	220	13,000	165	6,000		1,000	26,000										
												Me	Me	Me	Me						
					375*							Me	Me	Me	Me	Wh	Re				
170			3,250	4,400	280+	13,000	230				33,000	Me	Me	Me	Me	Re Wh	Re				
750			12,500	18,500	225+	7,000	190	10,000		1,100	25,000*	Me	Me	Me	Me	Fx Wh	Fx				
			8,350		350*	17,000	2,400				35,000+	Me	Me	Me		Fx Wh	Re				
233			3,385	4,785	315+	15,000				2,900	35,000	Me	Me	Me	Me	Re Wh	Re				
233			4,100		350*					3,300		Me	Me	Me	Me	Fx Wh	Re				
												Me	Me	Me	Me						
			4,192	5,623	280	16,000					26,000						Fl				
248	25.4		4,145	5,920	279	15,200				2,200	36,500	Me	Me	Me	Me		Fl				
675					230	10,000	212	10,000			22,000	Me	Me	Me	Me	Fx Wh	Re				
				20,500	264	13,000					23,500	Me	Me	Me	Me	Fx Wh	Re				
												Me	Me	Me	Me	Fx Wh	Re				
939			Douglas DC-2 Design									Me	Me	Me	Me	Fx Wh	Fx Wh				
551			Lockheed 14 Design									Me	Me	Me	Me	Fx Wh	Re				
												Me	Me	Me	Me		Re				
					370+					3,900		Me	Me	Me	Me		Re				
			4,300		375*					3,900		Me	Me	Me	Me	Re Wh	Re				
			5,000		360*					2,400		Me	Me	Me	Me	Re Wh	Re				
755	24.2	8.8	11,900	18,300	266	10,500	197	9,000	75		23,000	Me	Me	Me	Me	Fx Wh	Re				
390			5,900	8,070	236	6,200				1,600	23,000	Me	Me	Me	Me	Fx Wh	Fx				
248	20.2		3,718	5,140	326	16,000			70	3,000+	38,500	Me	Me	Me	Me	Re Wh	Re				
232	24.2		3,913	5,570	350	17,000			65	3,000+	40,200	Me	Me	Me	Me	Re Wh	Re				
			4,100		350+		3,000*		65	3,000+	40,000+	Me	Me	Me	Me	Re Wh	Re				

Japanese Code Data

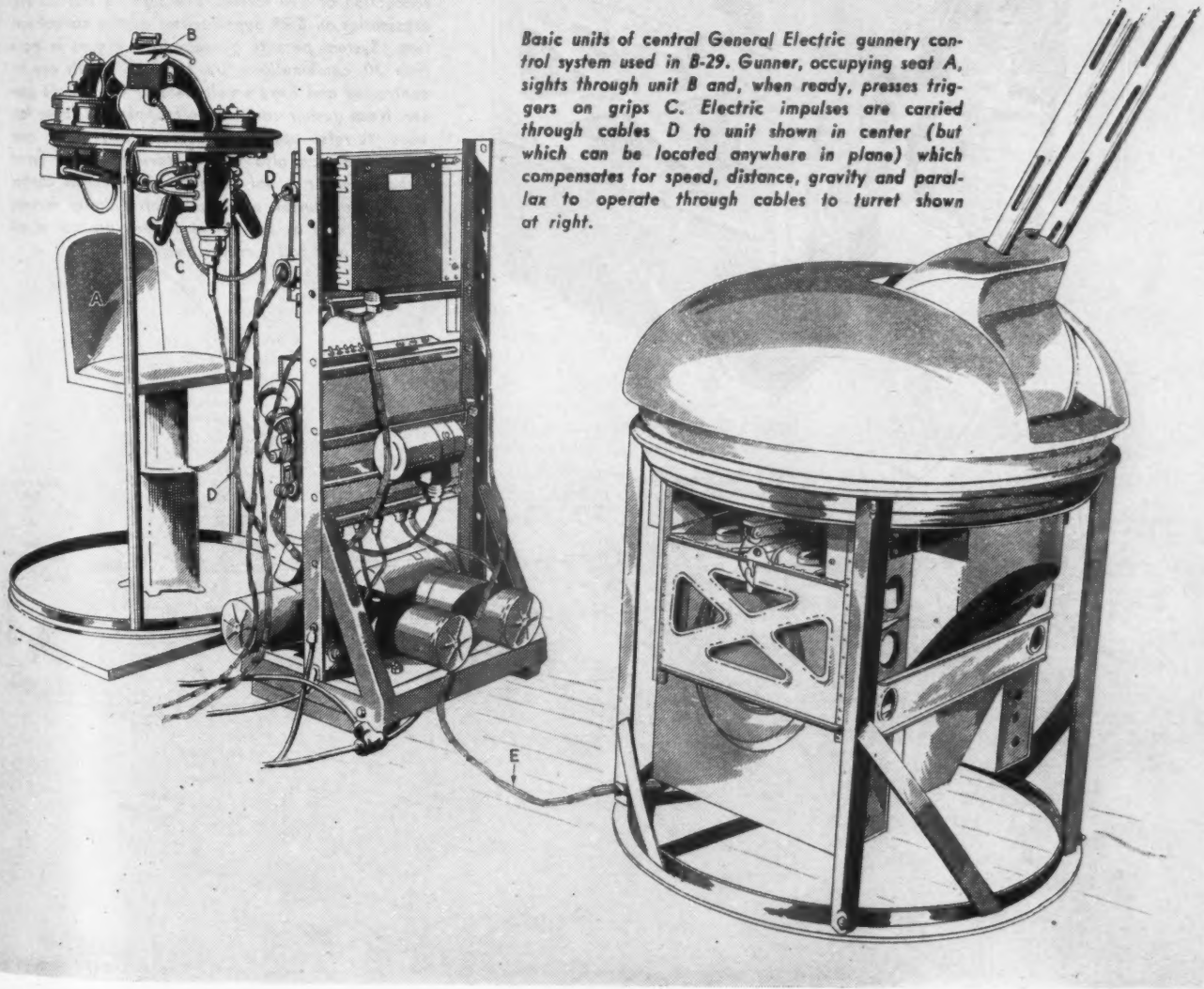
Under new code system for identifying Jap planes, when new Navy model appears it is given name and number 11. A structural change adds one number to first digit; engine changes adds to second. Army types have name and one number; any change increases the number. Army-Navy single and twin engine fighters and Navy recco float planes get male names; most others get female names. Transports get female names beginning with T. Dual-purpose planes take names according to primary use. In third column from left of Jap table Ar indicates Army type; Na indicates Navy. In fourth, or manufacturer's column, K stands for Kawasaki; Ka for Kawanishi; M for Mitsubishi; N for Nakajima; S for Sasebo; T for Tatchikawa; and W for Watanabe. Fifth column figures indicate year of plane's development, with 00 indicating Jap year 2600, which corresponds to our 1940.

AVIATION'S

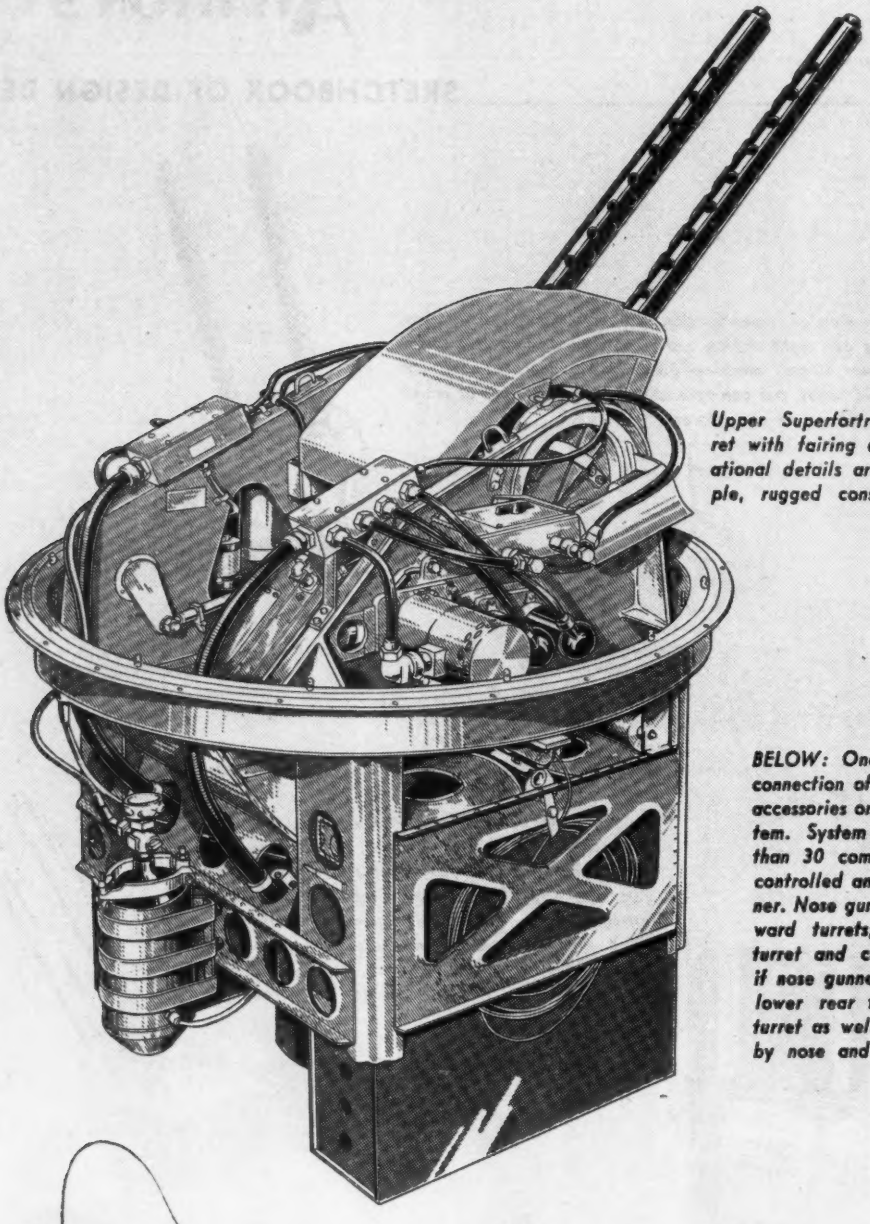
SKETCHBOOK OF DESIGN DETAIL



Exterior view of upper portion of Boeing B-29 Superfortress, showing gun sight station and remote controlled gun turret with twin 50-cal. machine guns. This gunner can fire not only this turret, but can take over two others, guns of which will be aimed at same target.

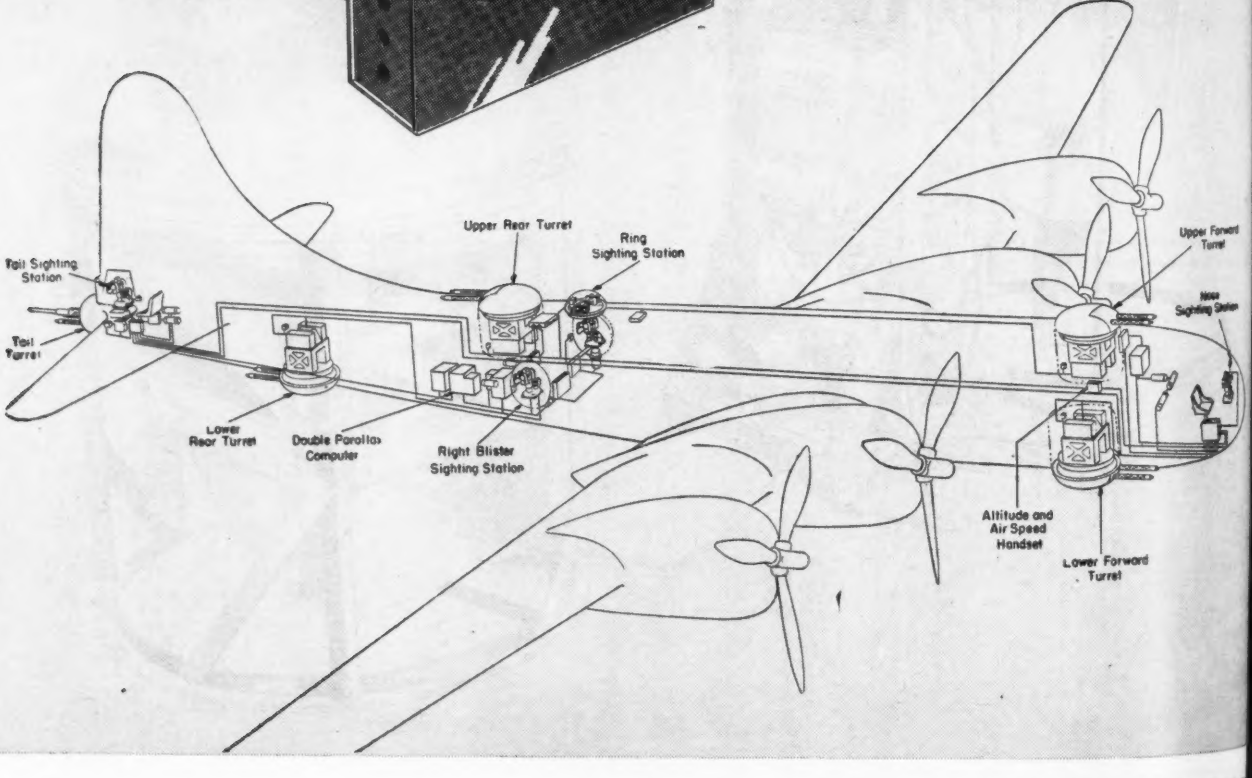


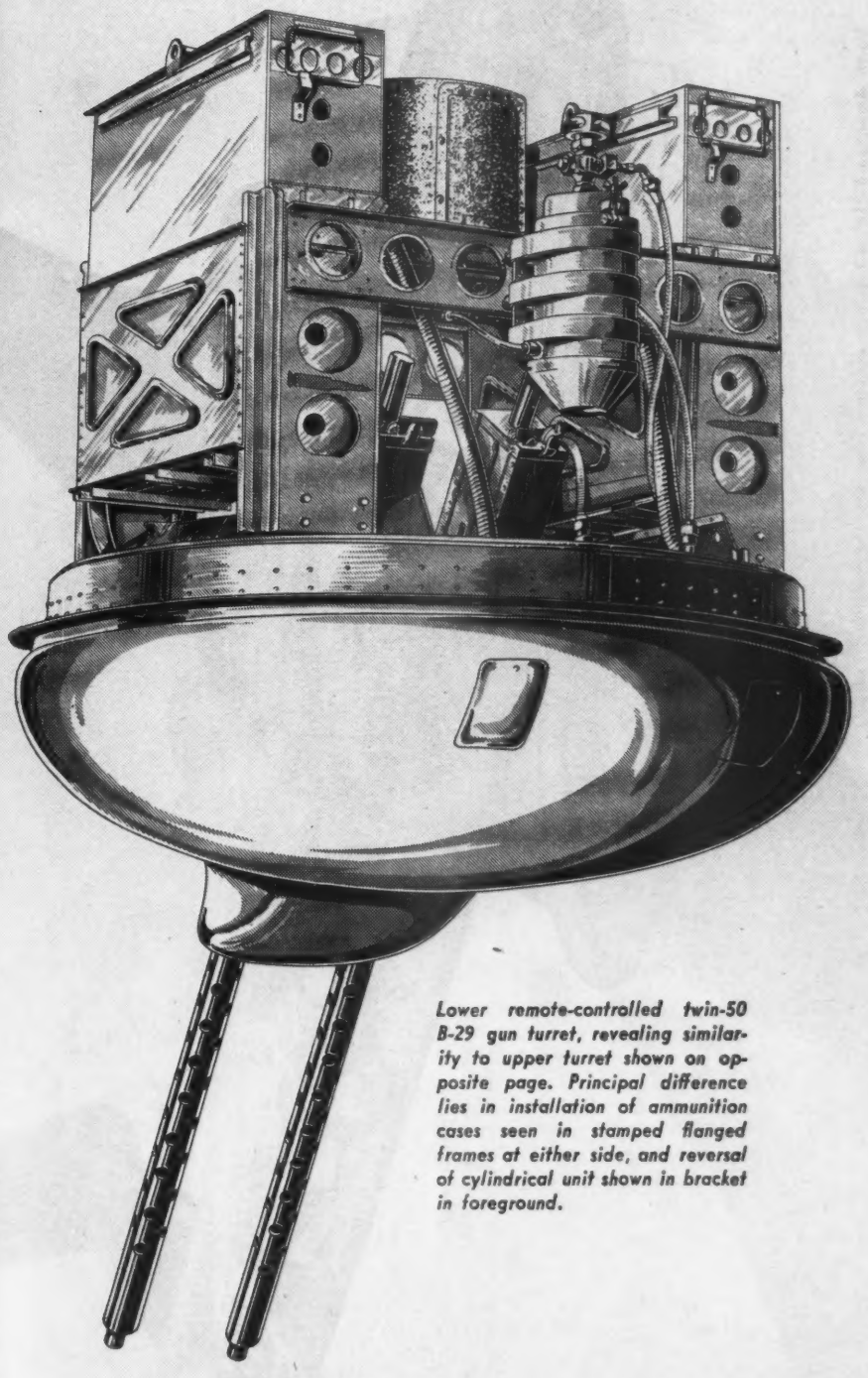
Basic units of central General Electric gunnery control system used in B-29. Gunner, occupying seat A, sights through unit B and, when ready, presses triggers on grips C. Electric impulses are carried through cables D to unit shown in center (but which can be located anywhere in plane) which compensates for speed, distance, gravity and parallax to operate through cables to turret shown at right.



Upper Superfortress twin-50 gun turret with fairing dome removed. Operational details are restricted, but simple, rugged construction is revealed.

BELOW: One-line circuit diagram showing interconnection of five turrets, five sighting stations and accessories on B-29 Superfortress gunfire control system. System permits gunners to fire guns in more than 30 combinations. Up to three turrets can be controlled and fired simultaneously by a single gunner. Nose gunner controls both upper and lower forward turrets; upper gunner controls upper rear turret and can also control forward upper turret if nose gunner is not using it. Side gunners control lower rear turret and can control lower forward turret as well as tail turret if they are not in use by nose and tail gunners respectively.

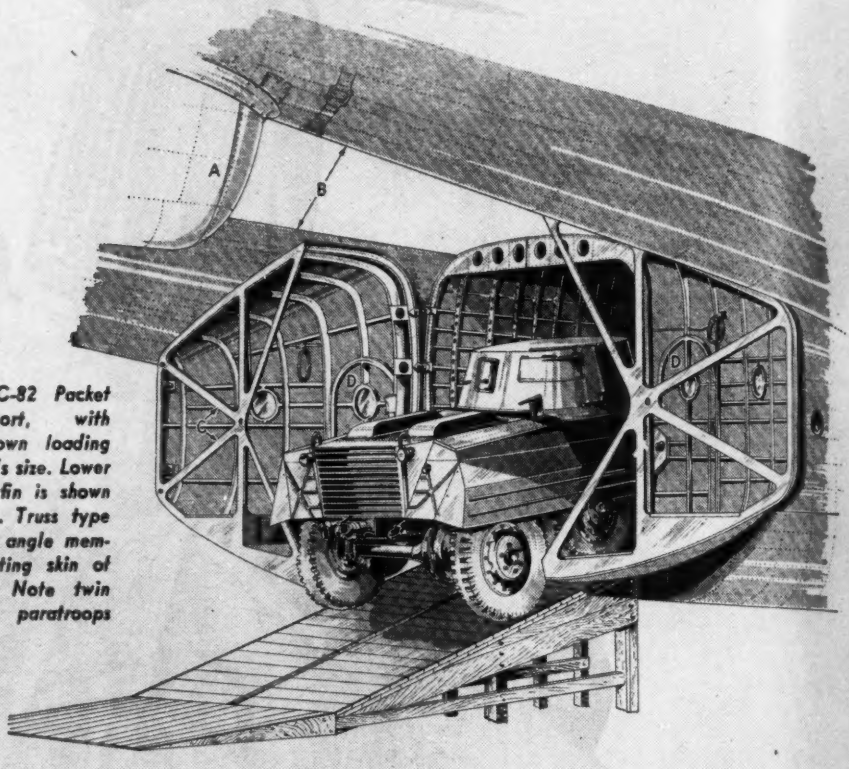




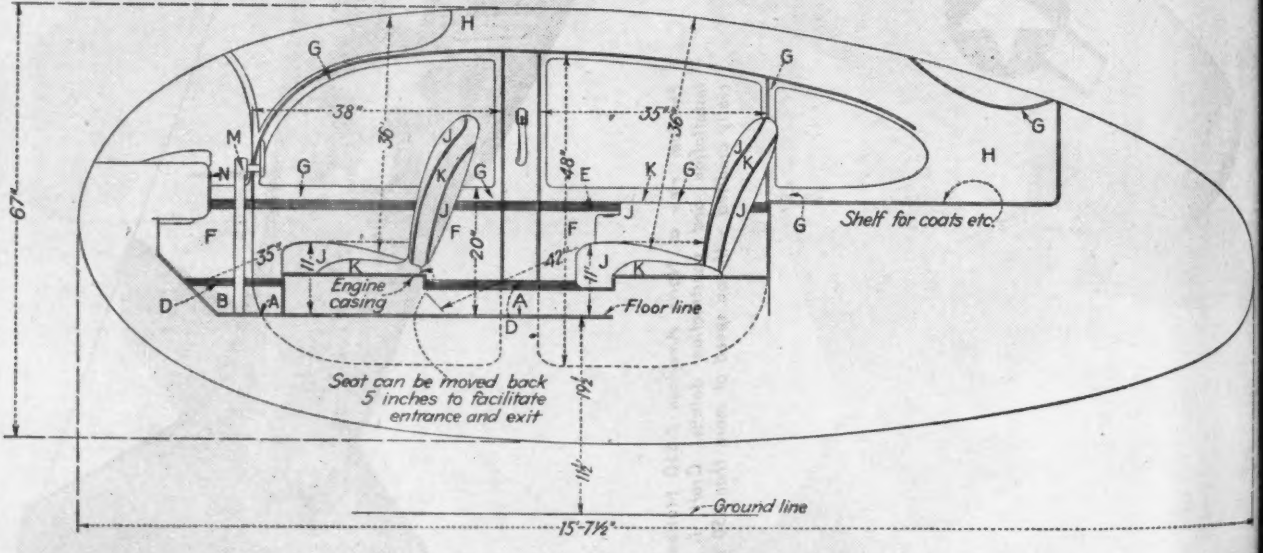
Lower remote-controlled twin-50 B-29 gun turret, revealing similarity to upper turret shown on opposite page. Principal difference lies in installation of ammunition cases seen in stamped flanged frames at either side, and reversal of cylindrical unit shown in bracket in foreground.

North American B-25H Mitchell in phantom view, showing installation of 14 50-cal. machine guns and 75-mm. cannon in addition to bomb load.

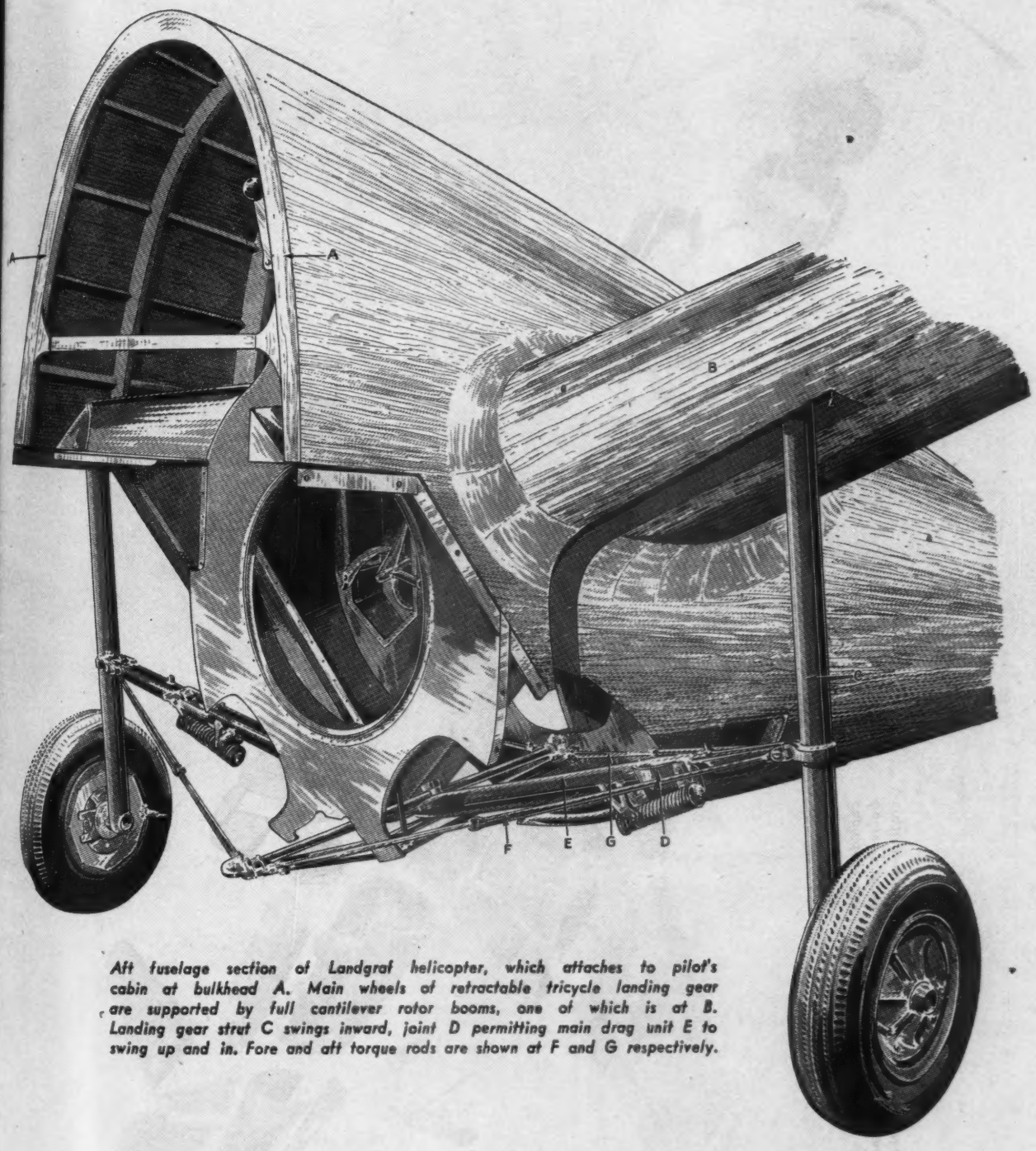
Phantom view of North American P-51D Mustang, showing installation and construction details. Craft is now officially credited with top speed of more than 450 mph.



Aft end of Fairchild C-82 Packet cargo-personnel transport, with armored car coming down loading ramp giving idea of craft's size. Lower portion of right vertical fin is shown at A; twin booms at B. Truss type frames C are of welded angle member construction, supporting skin of rear part of fuselage. Note twin doors D through which paratroops can exit.

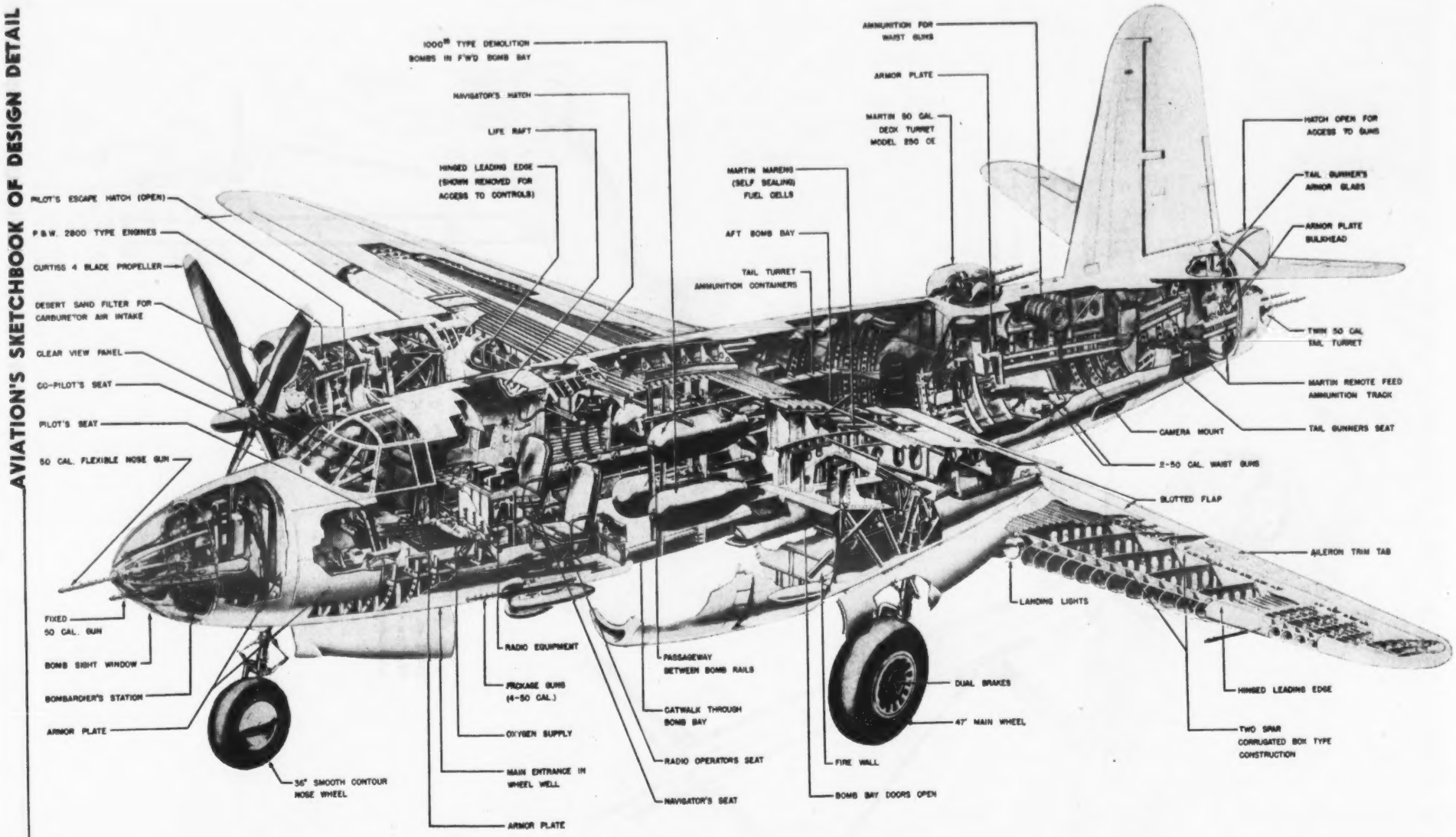


Cross-sectional view giving locations and dimensions of fuselage of Twin Coach helicopter now under development.

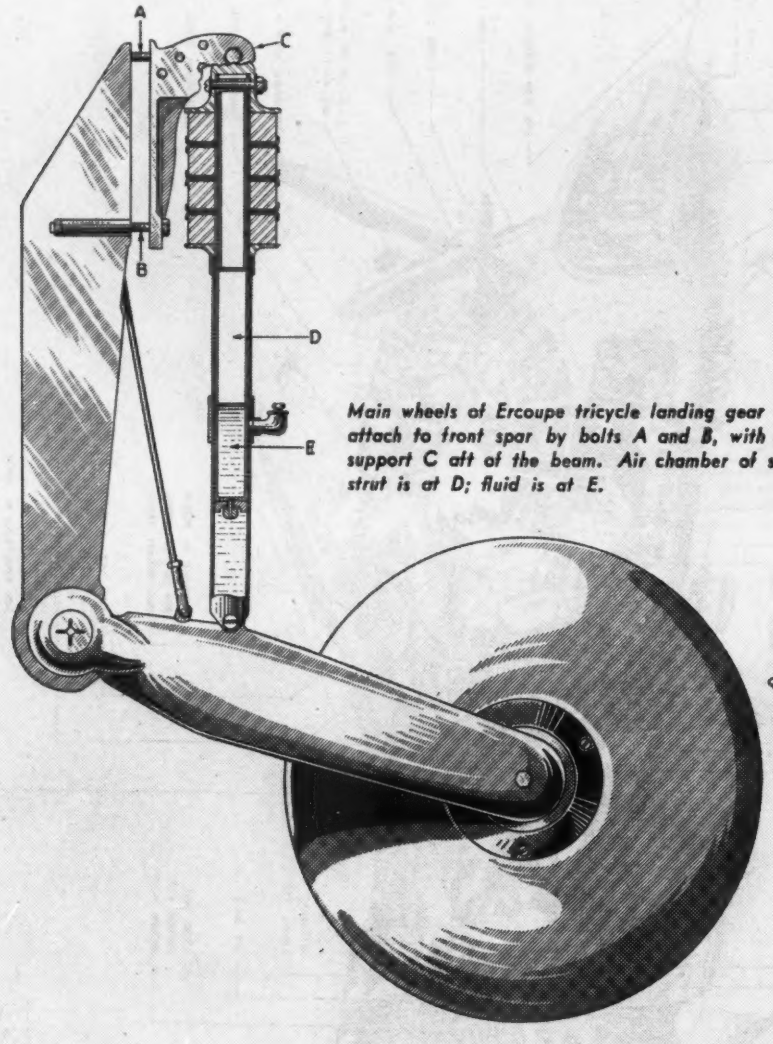


Aft fuselage section of Landgraf helicopter, which attaches to pilot's cabin at bulkhead A. Main wheels of retractable tricycle landing gear are supported by full cantilever rotor booms, one of which is at B. Landing gear strut C swings inward, joint D permitting main drag unit E to swing up and in. Fore and aft torque rods are shown at F and G respectively.

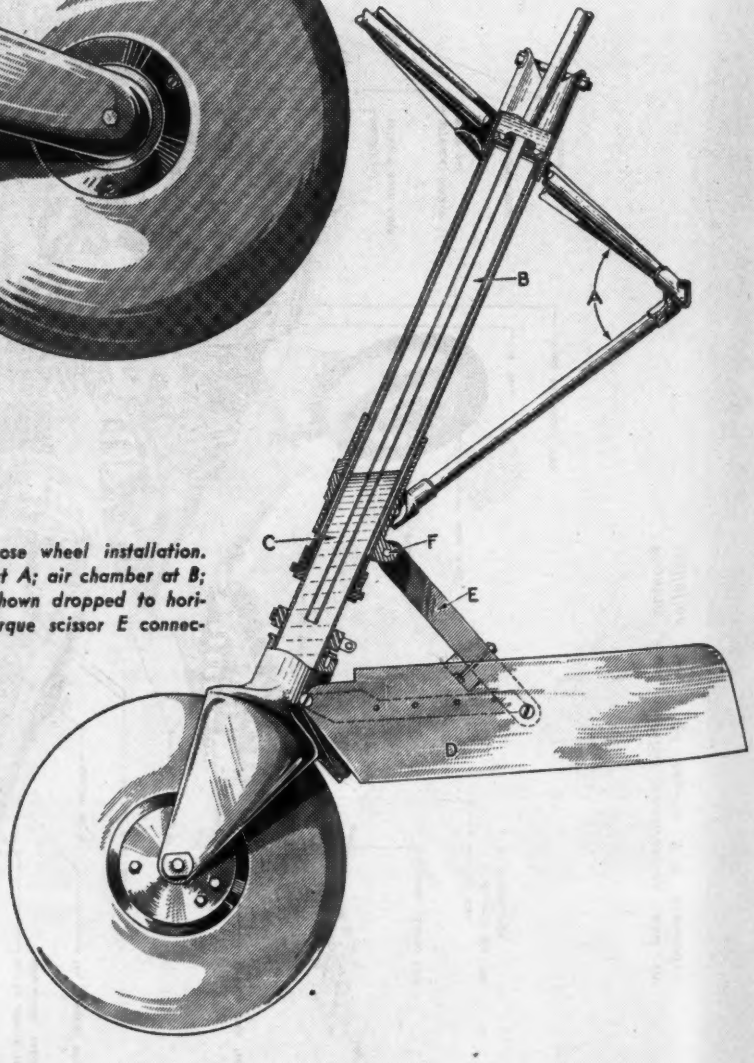
Exploded view of Vought F4U-1 Corsair ship-board fighter showing major assembly components, including drop tank which gives added combat range.



Phantom view showing construction and installation details of Martin B-26 Marauder.

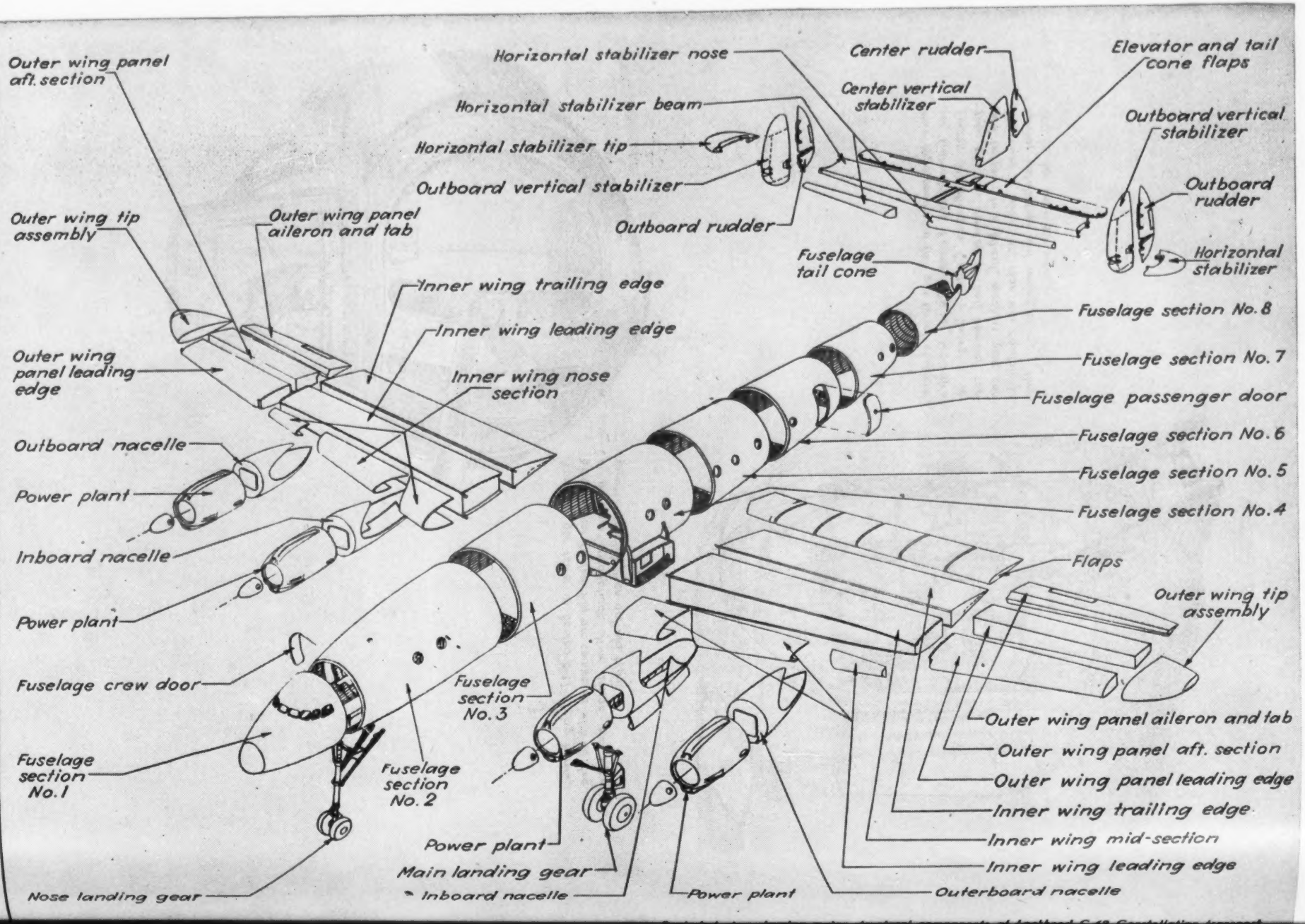


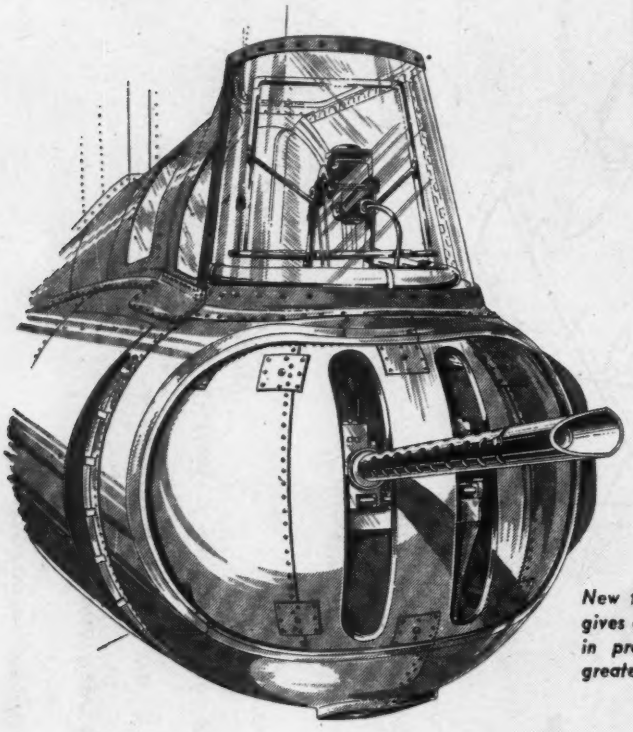
Main wheels of Ercoupe tricycle landing gear units attach to front spar by bolts A and B, with oleo support C aft of the beam. Air chamber of shock strut is at D; fluid is at E.



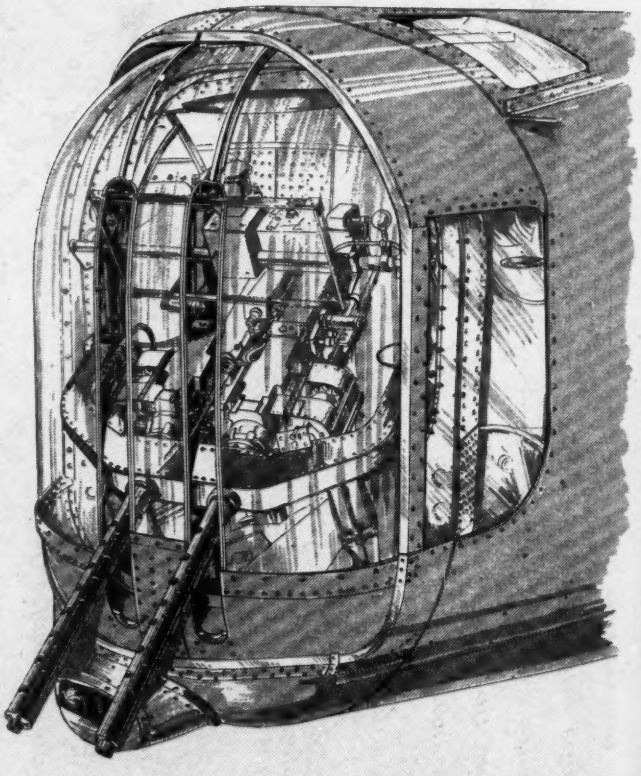
Phantom view of Ercoupe nose wheel installation. Engine mount members are at A; air chamber at B; fluid at C; and fairing D shown dropped to horizontal position to reveal torque scissor E connection F.

AVIATION'S SKETCHBOOK OF DESIGN DETAIL

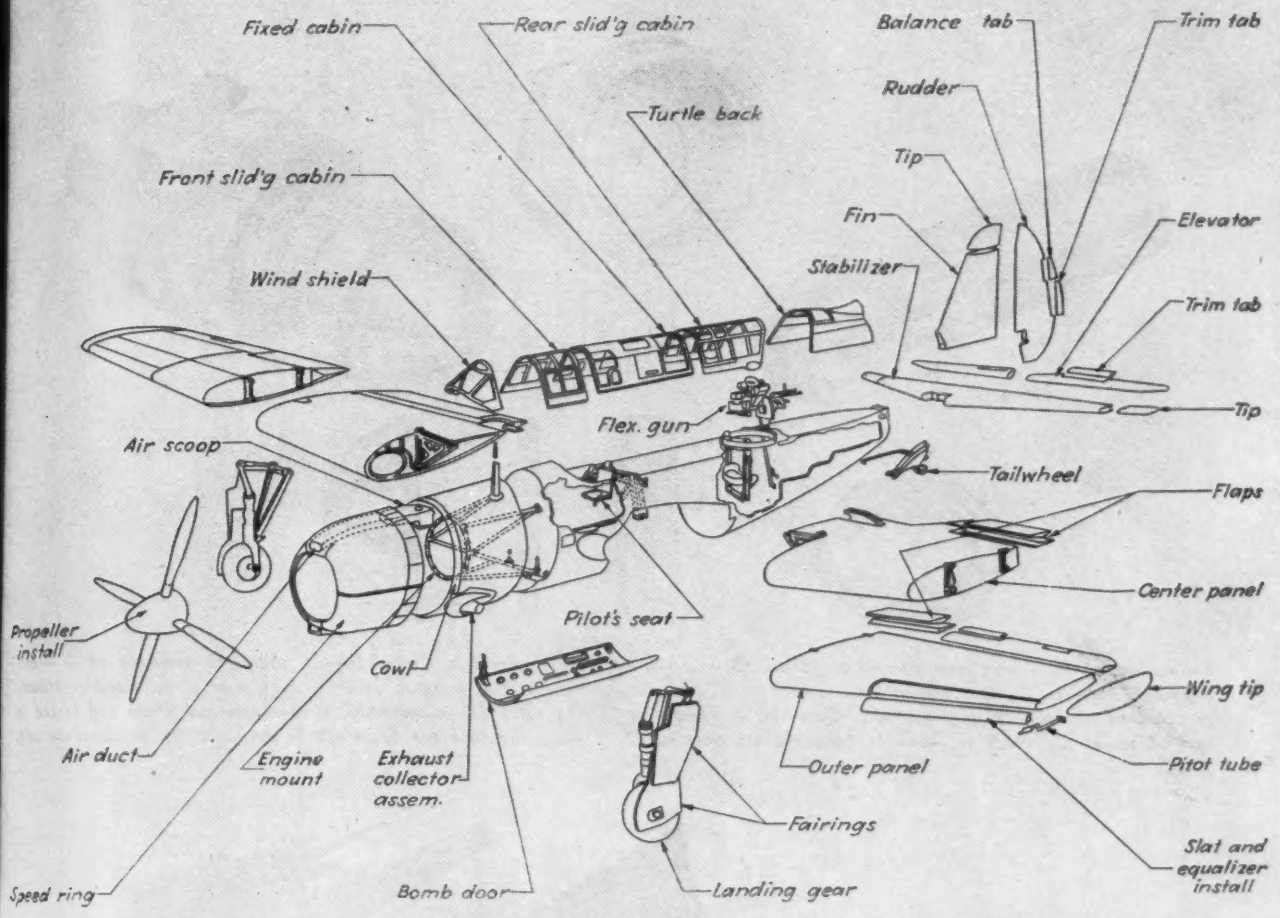




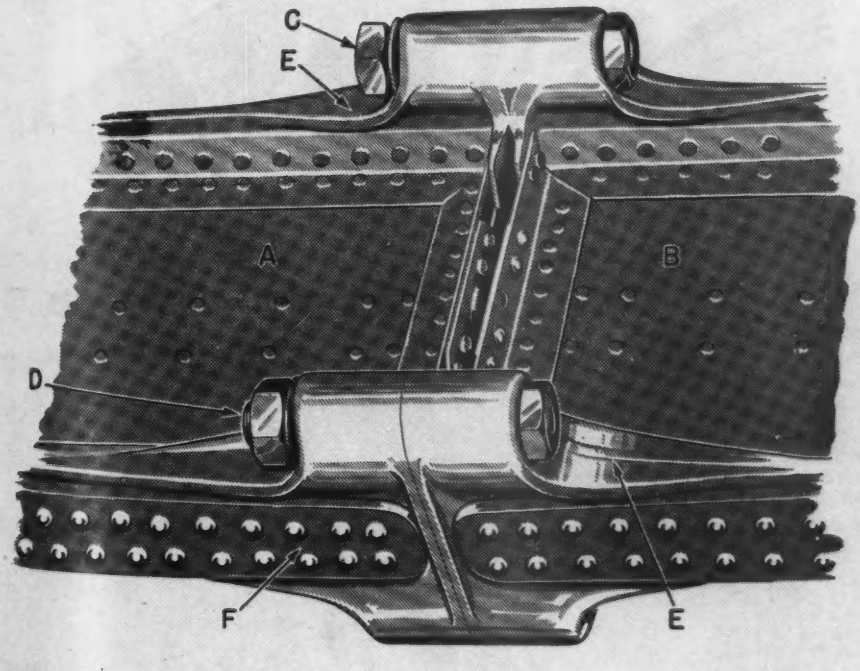
New tail gun turret of Boeing B-17 Flying Fortress gives gunner 90-deg. fire arc compared with 60 deg. in previous installations. New design also gives greater visibility than did old type.



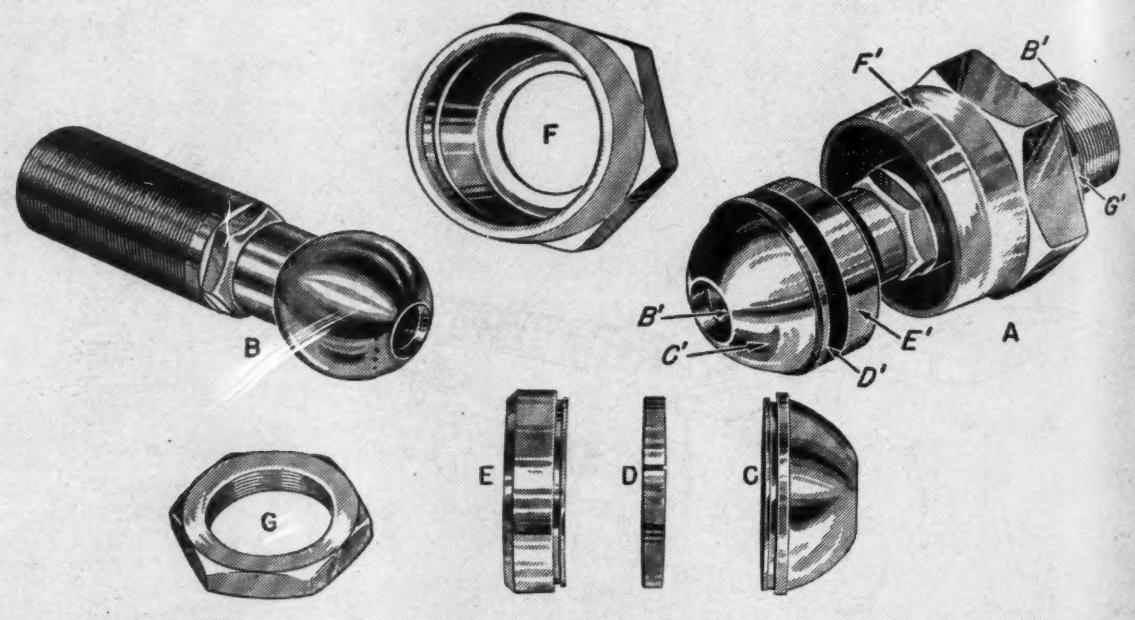
New type hand-held tail gun turret designed for Consolidated Vultee B-24 at Convair's Tucson Modification Center. Swinging on yoke which is pivoted on ball bearings top and bottom, twin 50-cal. machine guns can be swung in wider arc than was possible in former installation and saving of more than 200 lb. has been achieved.



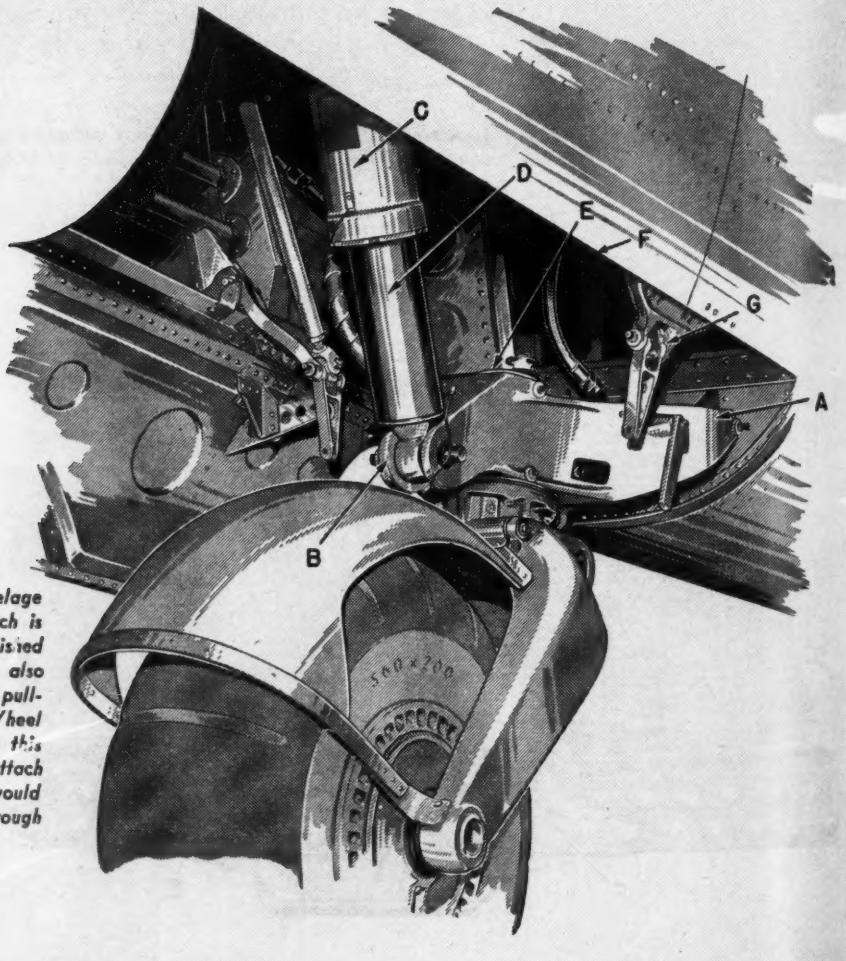
Exploded view of Curtiss SB2C Helldiver carrier-borne dive- and torpedo-bomber showing major assemblies.



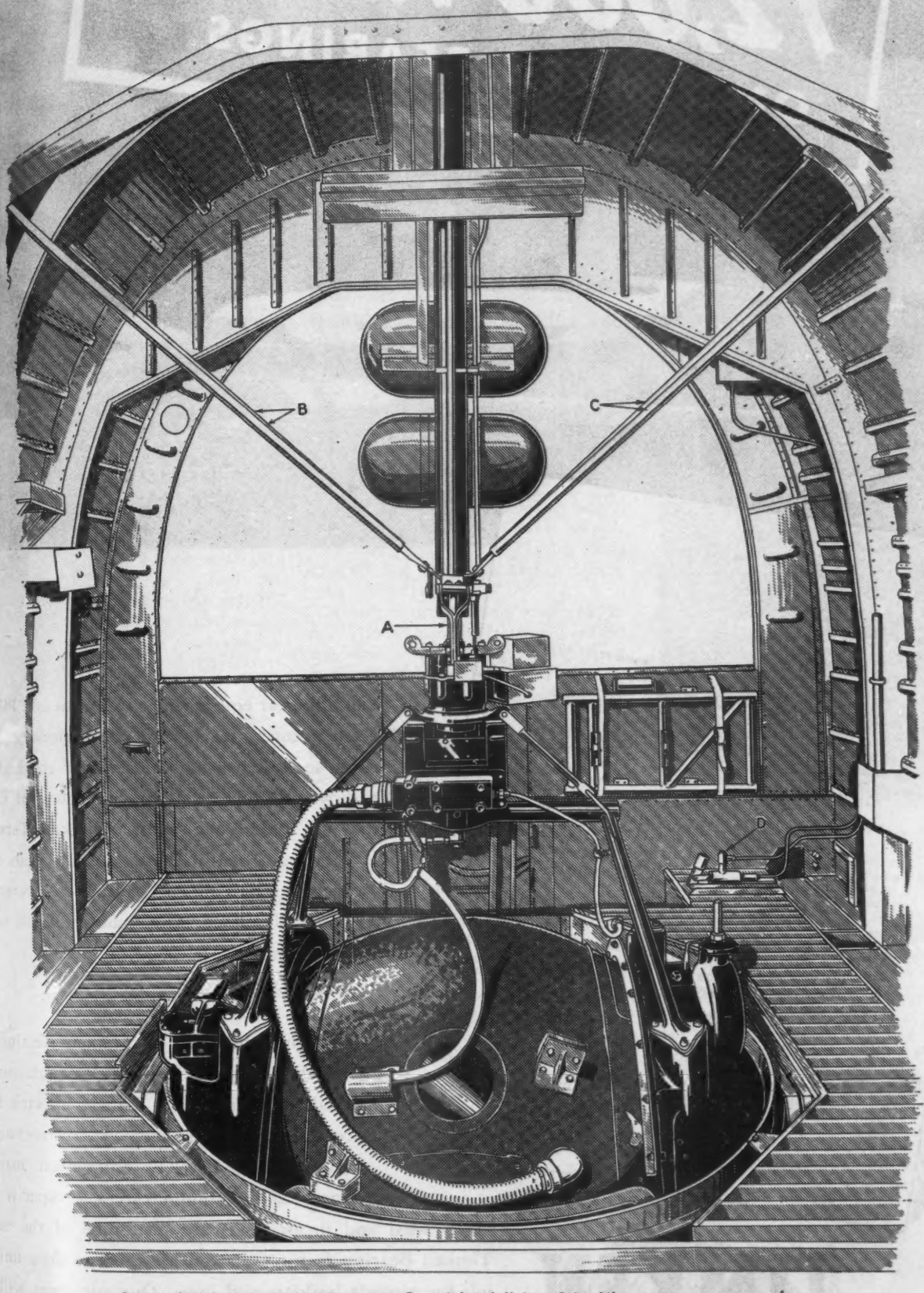
Detail sketch of JU-88 stabilizer spar connection. Spar is made in two sections, with left-hand section at A and right-hand at B. During assembly or repair, spars are fitted into tail section and joined by four bolts, C and D as shown, and a corresponding pair on opposite side. Forged fittings E are riveted to top and bottom of spars through plates E.



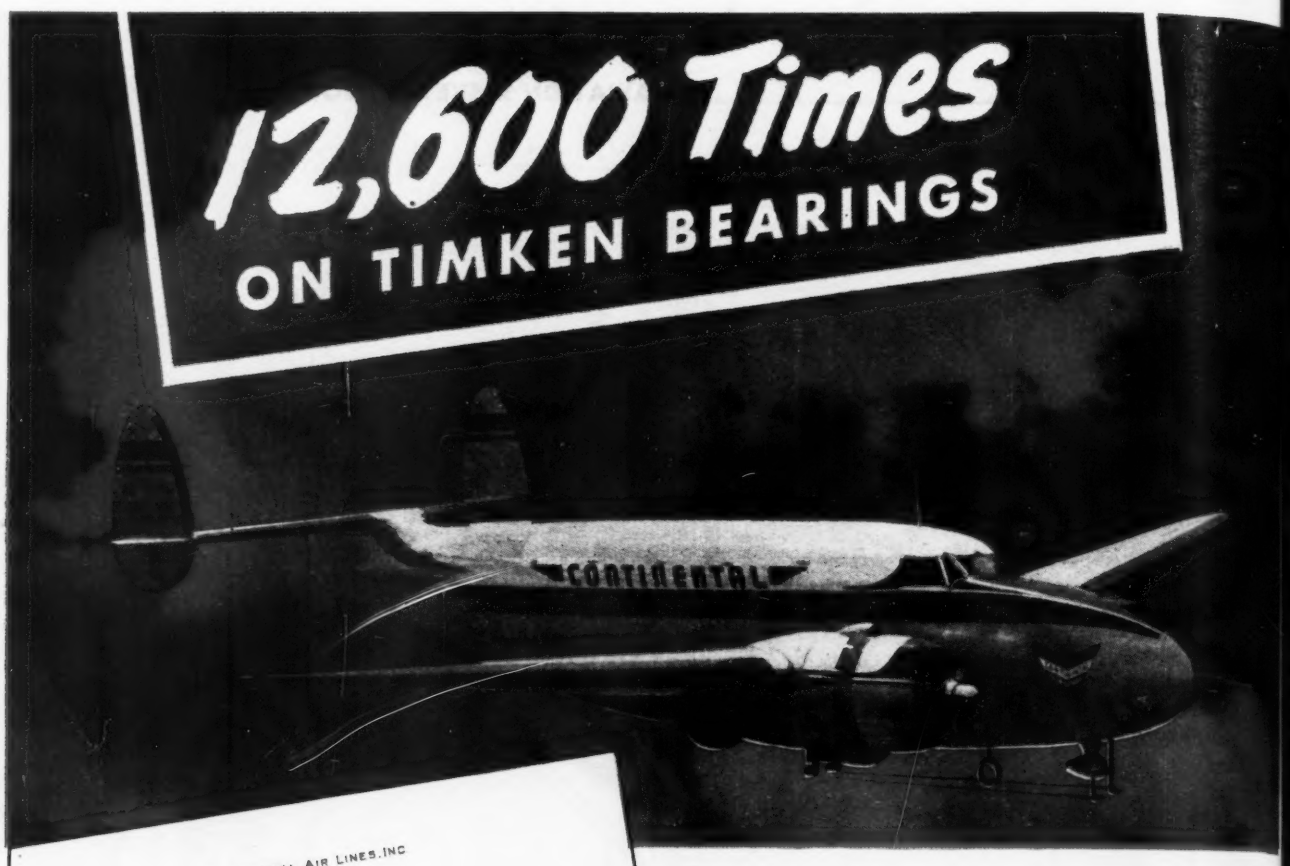
Ball-and-socket type wing spar connection for JU-88 is shown in assembled form at A. Ball end of strut is at B and its relation to complete assembly is shown at B'. Over this is fitted front half of socket C, which is shown in complete assembly at C'. Next comes lock ring D — in complete assembly at D' — and rear half of socket E which, in turn, is at E' in assembly. Mounting nut F (F' in assembly) is then attached firmly and locked in place by lock nut G, which is shown at G' in complete unit.



Tail wheel of JU-88 attaches to fuselage bulkhead at two points, one of which is shown at A. Retraction is accomplished through hydraulic piston C—which also takes part of load into airframe—by pulling up on yoke through point B. Wheel swivels in yoke through axle E. In this sketch fairing door, which would attach along line F, has been removed. It would be closed after retracting wheel through mechanism G.



Retractable ball turret installation in Consolidated Vultee B-24 Liberator moves up or down on hydraulic piston A, held in position by torque tubes B and C. In normal operation power is provided from plane's hydraulic system, but emergency hand pump D is also provided.



CONTINENTAL AIR LINES, INC
MUNICIPAL AIR TERMINAL
DENVER, COLORADO

ROBERT F SIX
PRESIDENT

December 7, 1944

Chief Engineer
The Timken Roller Bearing Company
Canton 6, Ohio

Dear Sir:

On part of Continental's routes the distances between stops are quite short---we average a take-off and landing for every 38 minutes of flying time. As a result, landing gear equipment on Continental planes is subjected to severe service and the various landing gear parts, such as bearings, must be of the highest quality.

I was pleased to notice in a recent report by our Maintenance Department that the Timken Tapered Roller Bearings used in both the landing gears and the tail wheels on our planes have been averaging 8,000 hours of service, which represents over 12,600 landings and take-offs.

Very truly yours,

Robert F Six
President

"....Landing gear equipment on Continental Planes is subjected to severe service and the various landing gear parts, such as bearings must be of the highest quality," writes Robert F. Six, president of Continental Air Lines, and adds: "Timken Tapered Roller Bearings used in both landing gears and tail wheels on our planes have been averaging 8,000 hours of service, which means 12,600 take-offs and landings."

* * *

This "highest quality" in Timken Bearings is the result of the most precise manufacturing methods plus unexcelled Timken Electric Furnace Alloy Steel. Compactness, lighter weight, freedom from friction, economical maintenance and maximum carrying capacity for both radial and thrust loads are just some of the many Timken Bearing features that enable them to do a unique job for aircraft builders and users. Our engineers will be glad to give you full details and make specific recommendations to meet your particular need. Why not write? The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TAPERED ROLLER BEARINGS

The Place of Industrial Research Prewar and Postwar

PART II OF A SERIES

By K. R. JACKMAN, *Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego*

From the vantage point attained by today's highly expedited wartime laboratory efforts, Author Jackman carefully examines the status and aims of research—to offer, in lucid perspective, a bridge between yesterday's initial progress and tomorrow's potentials . . . Second in a group of articles gaging aircraft development, test, and research.

"Research is an organized method for keeping you reasonably dissatisfied with what you have."—C. F. Kettering.

AN ATTEMPT WAS MADE, in Part I of this series, to show that industrial research in the present-day aircraft laboratory tended to be *applied research, development,* and *control testing* to keep "the planes rolling and flying"—rather than the *academic* or *basic research* of the university or foundation laboratory to "solve tomorrow's problems".

Research laboratories in every industry are in a state of flux at the present time—a healthy sign in an open-minded profession—in efforts to meet the changing demands of warfare and the predictions for the postwar world. Science and engineering are moving too rapidly to allow any laboratory to crystallize and stand still, even for a year.

That old adage which states that "In the field of observation chance only favors the mind which is prepared" may well be applied to the personnel and resources of a modern industrial laboratory; for six months gained over one's competitor in tomorrow's highly-competitive world markets may mean success or failure. In no other industry are there so many glaring examples that "those who follow are always behind" as in the modern aircraft field. The "cleanest" plane with the best performance or latest gadgets will win today's battle or tomorrow's postwar customer orders.

Before covering the specific problems of the aircraft laboratory, however, there are several general problems, common to most research laboratories, which bear consideration. The rapid growth of research and its distribution in the prewar years may indicate a trend which may be followed in postwar activity.

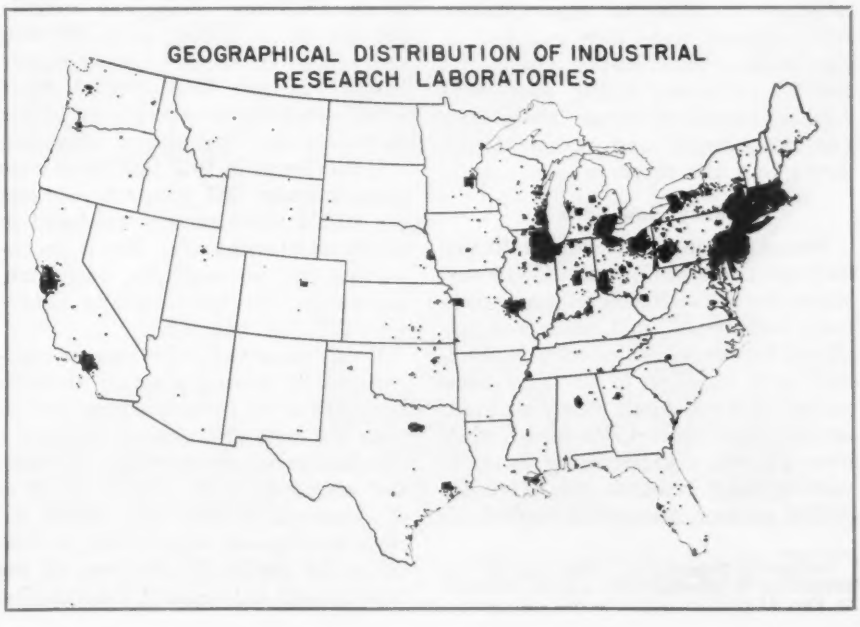
Distribution of Applied Research

In 1920 the National Research Council recorded the existence of less than 500 industrial research laboratories, maintained by commercial industrial concerns; in 1938 there were recorded 1,769; in 1940 there were 2,264; and today, were the true figures to emerge from the cloud of military secrecy, there are probably considerably more, representing an annual expenditure of over $250,000,000.

Research is, therefore, a sizeable industry in both the financial and personnel employment fields, quite apart from its inherent possibilities of success or failure to industries with which it is

Working on preliminary structure of an "altiliner" pressure cabin of tomorrow, Convair workers employ Celstrain gages to determine strength factors upon which final engineering will be based.

Mapped here is distribution of research laboratories of our various industries as recorded in 1940, with each dot representing one laboratory. (From "Research—A National Resource," 1940, courtesy National Research Council)



associated. Gaged in terms of employment in 1938, the "research industry" was equal in importance to that of dyeing and finishing of cotton fabrics which, in 1937, ranked among the 45 manufacturing industries which provided the largest number of jobs.

The development of industrial research has not proceeded uniformly in all industries; some established large research laboratories at an early date, whereas others considered research an unimportant activity and consequently their research staffs remained small. There are many factors which may influence the research requirements of a particular industry: The character of the processes involved, the age of the industry, the nature of the demand, the degree of competition, and the size and type of enterprise.

Inasmuch as this series is being presented to crystallize a few ideas on the probable scope, contributions, and the problems of the applied research, development, and routine test laboratories in the aircraft industry in the early postwar years, it may be desirable to study a few statistics of a normal industrial year before this recent armament race began, assuming that the present expanded laboratories will be somewhat reduced with the cessation of the war. The year 1938 may be as typical as any, and for it we have a very complete laboratory survey made by the National Research Council.

Maurice Holland[I-12] of this Council, estimated in 1938 that approximately 500 scientists were then engaged in pure-science experiments (basic research), whereas 30,000 men were working in applied science laboratories (on development and routine tests) throughout the country.

Many Had None

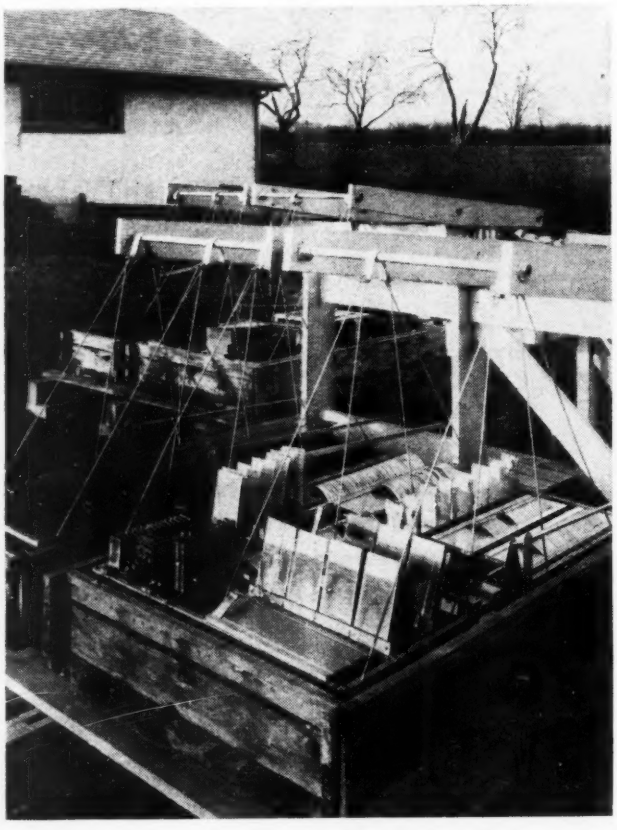
Perazich[I-12] in his splendid statistical study for the same Council, 1938 survey, states that of the 50,000 research scientists, technicians, and assistants employed by American industry in 1938, half were attached to 45 large companies. The other half were distributed among more than 1,700 firms, while over 150,000 manufacturing concerns were *without* research laboratories.

The greatest amount of applied research was being done, in 1938, in the relatively new mass-production industries, such as electrical goods, rubber, petroleum, industrial chemicals, and automobiles. These were also the industries in which, during the period 1920–1938, research activity grew most rapidly, as measured in terms of personnel employed.

For all the industries, the increase in the reported laboratory personnel between 1927 and 1938 was roughly 130 percent, or adding of 25,300 men and women in 11 yr. Approximately 10,0000, or over 40 percent, of these added personnel were employed by the chemicals and petroleum industries.

It was found in 1937 that there were approximately 303 research workers per 10,000 wage earners employed in the chemical industries. For radio apparatus and phonographs, petroleum, and rubber the corresponding figures were 232, 207, and 173.

It is difficult to make current comparisons of aircraft research strength with that of the industries noted—first, since the present technical manpower distribution is not generally released; and second, since the above definition of "research worker" may either include development engineering personnel or be limited to members of the development and research laboratories.



This apparatus is used to verify resistance of various metallic finishes to sea water. In predetermined cycles, racks of test pieces are automatically immersed, then raised to drain and dry. (Aluminum Co. of America photo)

From the meager information that has come to the writer's attention, the probable applied research personnel (including development engineering) during the wartime boom of the last two years may not exceed 1 percent of employed wage earners, whereas in the industries listed above it is possible that the wartime average is close to 5 percent, or maybe more.

It is therefore again obvious that the aircraft industry will have to face the research and development problems of the postwar laboratories as a really serious issue.

In 1938 the geographical distribution of research laboratories was influenced by the location of the specific industry. For instance, research in the chemical industry was concentrated in New Jersey, with Delaware and New York next in importance. These three states together employed more than half of those engaged in research of interest to the chemical and allied products industries.

About four-fifths of the research workers in the automobile industry were located in Michigan, the center of the industry, and practically all of those engaged in the development of agricultural implements were found in Illinois.

Laboratories engaged in rubber research were located in Ohio and New Jersey. Half of all research personnel in California were engaged, in 1938, in petroleum research, with the percentage still higher in large oil-producing states such as Texas and Oklahoma. The largest proportion of research on food products was done in Chicago, the center of the meat-packing industry, and all leading laboratories in the field of electrical communications were located in the New York metropolitan area and in New Jersey.

Approach to Research

The technology of scientific industrial research is too vast to be caught between the covers of any one book and can, accordingly, merely be scratched in such a series of articles as this. Those who wish working rules for the conduct of laboratory experimentation might thumb whole libraries for technical details, still not too successfully.

Fortunately, there are eminent authorities to advise the puzzled novice. Industrial research is so new that the

I-12 Part I, Reference 13. (See page 207 for explanation of reference keys and all references to Part II.)

men who blazed the trail are still active, and these pioneers are willing to indicate the pitfalls and how to avoid them.

M. Ross, in his splendid book *Profitable Practice in Industrial Research*,[1-30] presents the accumulated experience of 25 yr. in American research, (1918 to 1932). Moreover, the directors of the great research laboratories point out, in their own words, the paths which they have discovered to lead to the probability of success in research, and at the least expenditure possible on unproductive blind-alley experiments.

Bichowsky[1-4] in his helpful book *Industrial Research*, states that most industrial laboratories have developed within organizations by a sort of internal concretion like that forming pearls—or boils—initially caused by some accidental irritant. Growing as they have, without reference to the experience of others, some of the laboratories have certainly proven to be pearls of great price, indeed; others have been classified as "pains in the neck". There are more or less general rules of research management and organization which make the difference in drawing ultimate comparisons with the pearl or the boil.

This series of articles—each on specific parts of industrial research laboratory work, incorporating much pertinent thought from others, and including specific bibliographies—may be considered as an occupational guide for the young engineer and scientist, a manual for the research director and for the business executive, real or potential.

Pertinent Viewpoints

There is much wisdom in Baekeland's oft-quoted admonition: "Commit your blunders on a small scale (in the laboratory) and make your profits on a large scale (on the production line).

"As for industry", states L. V. Redman, director of research for the Bakelite Corp., "if we do not become, and continue to be, as much interested in adequate promotion of research in pure science as we are now interested in its exploitation, we shall find the indispensable life-giving stream of new knowledge drying up at its source."

The industrialist puts aside a surplus in order that dividends may be maintained uninterruptedly. "Why not a surplus", asks Redman, "in order that the increment of new knowledge of value to his industry be not abated?" New knowledge becomes tomorrow's investment of greatest wealth.

"Men have acquired", continues Redman, "monopolistic control of raw materials and of patent rights. If they are not also acquiring a commensurate surplus of new knowledge through research, they will lose their monopolistic hold."

Successful industrial research depends upon competent men working together rather than an individual genius. At rare intervals the scientific field is astonished at the discovery of a long-sought principle by an inexperienced worker. Kane, of M.I.T., cleverly shows the savants' consternation in a recent cartoon (see below).

Hower, the laymen should not hold out hopes of being one of these untaught genii, for in today's organized research laboratories such "finds" occur only at rare intervals.

It was formerly possible for independent inventors to acquire the knowledge and skills essential for the most revolutionary inventions. With the continued growth in the size and complexity of industrial enterprises and in the volume of scientific knowledge, however, this became less and less feasible. Industry could no longer rely on random discoveries, and it became necessary to organize the systematic accumulation and flow of new knowledge.

This prerequisite for the rise of industrial research in its present proportions was being met by the formation of large corporations with ample funds available for investment in research.

In modern large industrial laboratories, whose work has become increasingly characteristic of today's research techniques, the research has itself become a mass-production industry. Just as division of labor in manufacturing made possible significant increases in labor productivity, so the

"First," said William James, "a new theory is attacked as absurd; then it is admitted to be true, but obvious and insignificant; finally it is seen to be so important that its adversaries claim that they themselves discovered it." (Cartoon, courtesy of Kane, M.I.T.)

application of this principle to research has improved the effectiveness of the scientific work. In the attack upon a complex problem, the work in these laboratories is systematically divided among specialists in the several sciences, or their branches. Each works on a separate phase of the investigation, and few need to know all the phases of the problem.

The effect of this division of labor on the quality and quantity of work is illustrated by Dr. Coolidge's statement that given two scientists of equal ability, if they would cooperate nicely with one another, their output should be much more than twice that of either of them working alone.

Engineer vs. Researcher

With the title "Research Laboratory" being adopted by every new testing institution and with the designation of former test engineers as "research laboratory analysts", it is not surprising that some sensitivity should be exhibited by the "old-line" research men concerning this new crop of engineers. A new-crop idea is that engineering development and research have the same ultimate objective—the enlargement of sales by the improvement, cheapening, diversification, or extension of application, of products. But whereas engineering development seeks advantage through the best utilization of available raw materials, research seeks new knowledge for future utilization as an industry might prospect for sources of better materials.

Dr. Larry Hawkins,[1-2] with years of experience as executive engineer of the General Electric Research Laboratory, states that in his experiences he has "seldom found in one man special aptitude for both engineering and research. The metal attitude required is wholly different. The successful engineer is the type that likes to deal with certainties. He likes to utilize materials whose properties he knows and has confidence in, and to produce therefrom concrete results in the way of new structures, new devices. He likes to see the tangible result of his labors. But the research man is primarily interested in the unknown. He seldom has the patience to carry a new idea through to a finished design. He differs from the engineer as an explorer differs from those who follow him to develop what he has found."

The engineer, for economic reasons, must be a devotee of standardization. His interest in the exceptional is in bringing it into conformity with standards. To the research man, however, the exceptional is in itself an inspiration and a guiding light.

Again in the relative importance of optimism and balanced judgment, Dr. Hawkins[1-2] feels that research and engineering are dissimilar. Optimism is more essential in research than in any other vocation. "It is easy to think of many reasons why a proposed experiment would be futile, but the man who makes the discoveries is the man who goes ahead and tries it just the same", advises Hawkins.

How similar is that phrase to the thought behind Kane's cartoon of the "Great Minds." It has been said that optimism is to research what vitamins are to the animal organism.

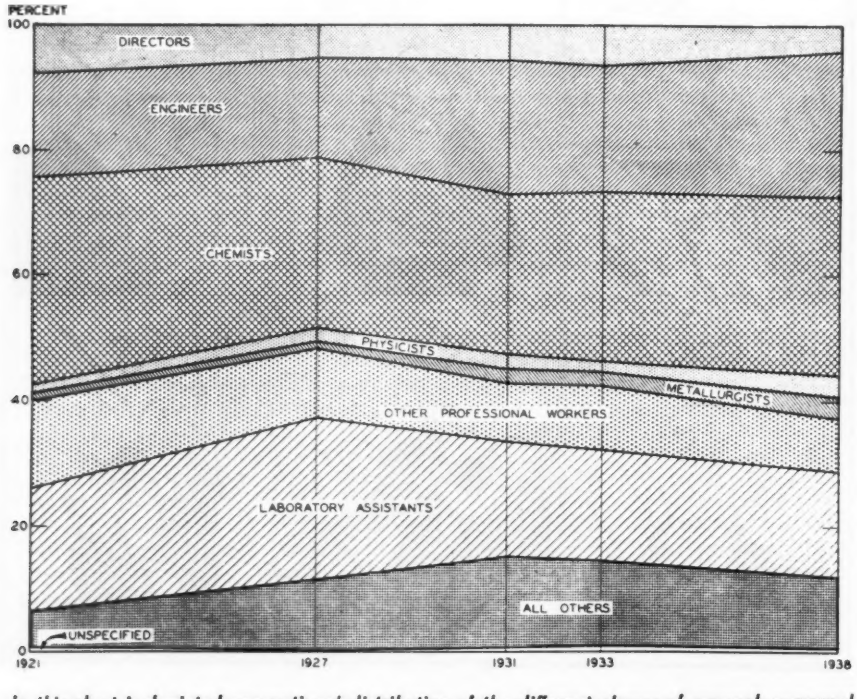
Optimism is, of course, essential to an engineer also, but it must be sternly ruled by sound judgment. The engineer does not possess the safeguard of the researcher, whose optimism, if excessive, is immediately checked by laboratory experiment. The engineer's mistakes, like the doctor's, may be fatal to others; but, unlike the doctor who can "bury his errors," the engineer must face his irate public and account for that "misplaced decimal point".

Ability "To See Things"

Imagination, but of different types, is an important asset to both researcher and engineer. Hawkins, from his vast experience with hundreds of both types of men, remarks that "the research man's imagination should be of the philosophical type, to enable him to coordinate his observations into hypotheses for experimental verification or disproof. The engineer, too, should be able 'to see things'; but the pictures his imagination is called upon to draw are usually of the tangible, mental presentations of the device he is to design. The imagination that depicts a new design of locomotive or airplane has a technique different from that used in dealing with the quantum of Planck, the atom of Bohr, or the wave mechanics of Schroedinger."

Many characteristics should be equally possessed by both research man and engineer. These should include clear thinking, industry, intellectual honesty, resourcefulness, perseverance, etc. Inasmuch as the "test engineer" or "research engineer" of the aircraft laboratory is a new individual, possessing the above necessary characteristics and engineering background and training—but who is also required, in the applied research problems of the laboratory, to use the intellectual restlessness, the ability to see wonders in the commonplace, the quick perception of, and interest in, the exceptional, and the high optimism and the philosophic imagination mentioned by Hawkins as the essentials of the research man—it is possible that a more practical genus of *homo sapiens* is in the process of evolution.

Would not such a research engineer in the aircraft industry, with some of the good qualities of both the research man and of the engineer, be a more practical answer in the modern applied research laboratory? Yes. Such men exist or can be trained, but only by the laboratory director who knows what he wants in laboratory personnel and has the patience to make his wishes come true.



In this chart is depicted occupational distribution of the different classes of research personnel during 1921-to-1938 period. (From "Industrial Research and Changing Technology," 1938, courtesy WPA.)

Customer Research

Possibly the General Motors Research Div. has found the proper balance between basic and applied research in its laboratories if it can live up to its motto "an eye to the future—an ear to the ground". To operate successfully today a large manufacturer must know what people are thinking, what they want, what they like or dislike about the products he makes for them, how these products can better serve people's needs and desires.

In the last four years most laboratories have been satisfied in meeting the specifications of the Army and Navy, their primary customers; in the coming postwar years, the Services will contribute only a fraction of the contracts, the public will be the party to satisfy. General Motors has a fact-finding group registering successful operation for years, and its Customer Research[II-2] fills the need of an auxiliary and more direct-line communication between producer and consumer.

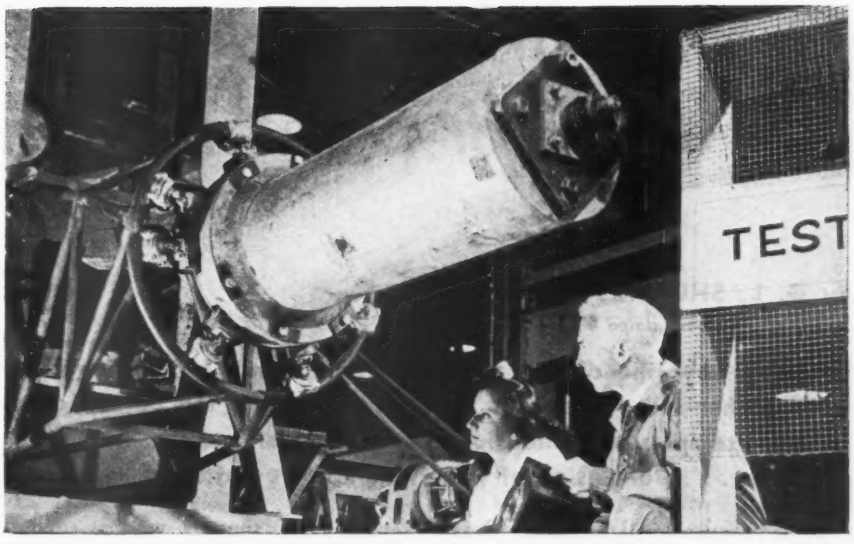
It might be very profitable for some far-seeing aircraft company to also have its *customer research* closely allied with its engineering department, research and development laboratories, and the sales department. It may well be, in the lean years ahead for the airframe manufacturer, that such a public contact will not only avoid guesswork in projecting new aircraft designs acceptable to John Q. Public but will also disclose many small household necessities needed by him and which can well be produced economically on an aircraft production line.

Surely our much publicized production ability, which has served to break all records in the output of military aircraft, can be applied to consumer's goods after a fact-finding research body has carefully determined the best course of action.

It may well be that today's aircraft research laboratories will play a part in bringing true this oft-repeated prediction by C. F. Kettering: "Each year we discover new things which a short time ago we did not even know existed. I cannot help but feel that in a very short time we are going to break loose another great piece of basic information which will keep us industrially busy for a great many years to come."

Rewards From Research

E. Emmet Reid, in his *Introduction to Organic Research*, says: "Those who love hard work and love it all the better because it is hard, those who try and fail and keep on trying, those who can suffer the loss of months of hard labor and start all over again, those who cannot be discouraged no matter what happens, are invited to undertake research."



"Applied research" is demanded in achieving laboratory duplication of flight conditions effecting airplane components. These Convair researchers are making vibration and fatigue studies with specially rigged engine mount.

In the recent motion picture *Madame Curie*, the lay public has had a fine opportunity of judging the years of hard back-breaking endeavor and the repeated failures of a true scientist. Few movies have so well depicted the continuing faith in the eventual success of a research enterprise—the extraction and identification of radium; and few have so well shown (despite it being true Hollywood fashion) the scientist's reward—the better living conditions of his fellowman.

"The 'slaves' of research", says Redman,[I-5] "are not driven from without but from within. They deserve our gratitude, but they ask no sympathy for their lot. The important happenings are 'inside the researcher'. They are there, because for every self-sacrificing act there is an impelling urge: for every determined rise above failure there is waiting the more-than-compensating joy of having created."

After years of experience in research, Hawkins states: "For the men with real aptitude and the requisite scientific training, research is by far the most attractive field I know. The successful research man may gain no greater financial rewards than the successful members of other professions, but in his work he shares with the artist the joy of creation, with the explorer the thrill of continual new discovery, with the scholar the zest of intellectual struggle and the triumph of intellectual achievement, and with the philanthropist the satisfaction of contributing to humanity's welfare.

Tradition tells us that Charles Goodyear was described by a neighbor as follows: "You will know him when you see him; he has on an India-rubber cap, stock, coat, vest, and shoes, and an India-rubber purse without a cent in it." Thus was early research in rubber justified, but not the unnecessary personal hardships. It was not good business, but we did not recognize it—not until World War I awakened us.

Now that we are about to enter the postwar era, maybe it is not too soon to plead with the managements of current businesses, as did the great Pasteur with the French people. "I beg you", he said, "take some interest in those sacred dwellings meaningly called laboratories. Ask that they be multiplied and completed. They are the temples of the future, of riches and comfort."

Or possibly the more modern maxim is economically more convincing to the modern industrialist: "Today's science is tomorrow's engineering, and the next day's industry."

References to Part II

Note: For added convenience in this series of articles, two numerals are employed in each reference key, the first numeral indicating the part number in the series and the second numeral being the reference number. Thus, (I-4) means "Part I, Reference 4."

(II-1) *What is Research* by L. T. Work, *Industrial and Engineering Chemistry*, Vol. 35, No. 2, p. 221, Feb. 1943.

(II-2) *Research—An Eye to the Future*, pamphlet published by General Motors Research Div., Detroit.

(II-3) *Industrial Research—What It Means to British Industry*, Sir Harold Hartley, F. R. S., published by Arthur D. Little, Inc., Cambridge, Mass.

(II-4) *Location and Extent of Industrial Research Activity In the United States*, Franklin S. Cooper, Director of Research, Haskins Lab., Inc., N. Y. C.—Section IV of *Research—A National Resource*—II, *Industrial Research*, Dec. 1940, National Resources Planning Board.

(II-5) *Science in Action* by E. R. Weidlein and W. A. Hamor, McGraw-Hill Book Co., Inc., N. Y. C., 1931.

(II-6) *The Social Function of Science* by J. D. Bernal, F.R.S., Berbeck College, Univ. of London, McMillan Co., N. Y. C., 1939.

(II-7) *The Development of Industrial Research In the United States* by H. R. Bartlett, Head, Dept. of English and History, M.I.T., Cambridge, Mass.—Section II of *Research—A National Resource*—II, *Industrial Research*, Dec. 1940, National Resources Planning Board.

Simplified Numerical Integration For Design Engineers

PART II

By G. L. SHUE, *Ph.D., Development Engineer, Consolidated Vultee Aircraft Corp.*

Detailing how the difference-table method may be employed to solve higher-order equations in aircraft design, the author gives concise examples of application to heat transfer and compressibility problems . . . Conclusion of this two-part presentation.

TO PROCEED to higher-order equations, the difference-table method may be expanded, although this naturally involves more work because several tables must be worked concurrently. The number of tables depends on the order of the differential equation. For example:

$$\frac{d^2y}{dx^2} = x + y + 1 \qquad \begin{cases} x_o = 0 \\ y_o = 1 \\ \left.\dfrac{dy}{dx}\right|_o = 1 \end{cases}$$

The solution is:

$$y = 2e^x - x - 1$$

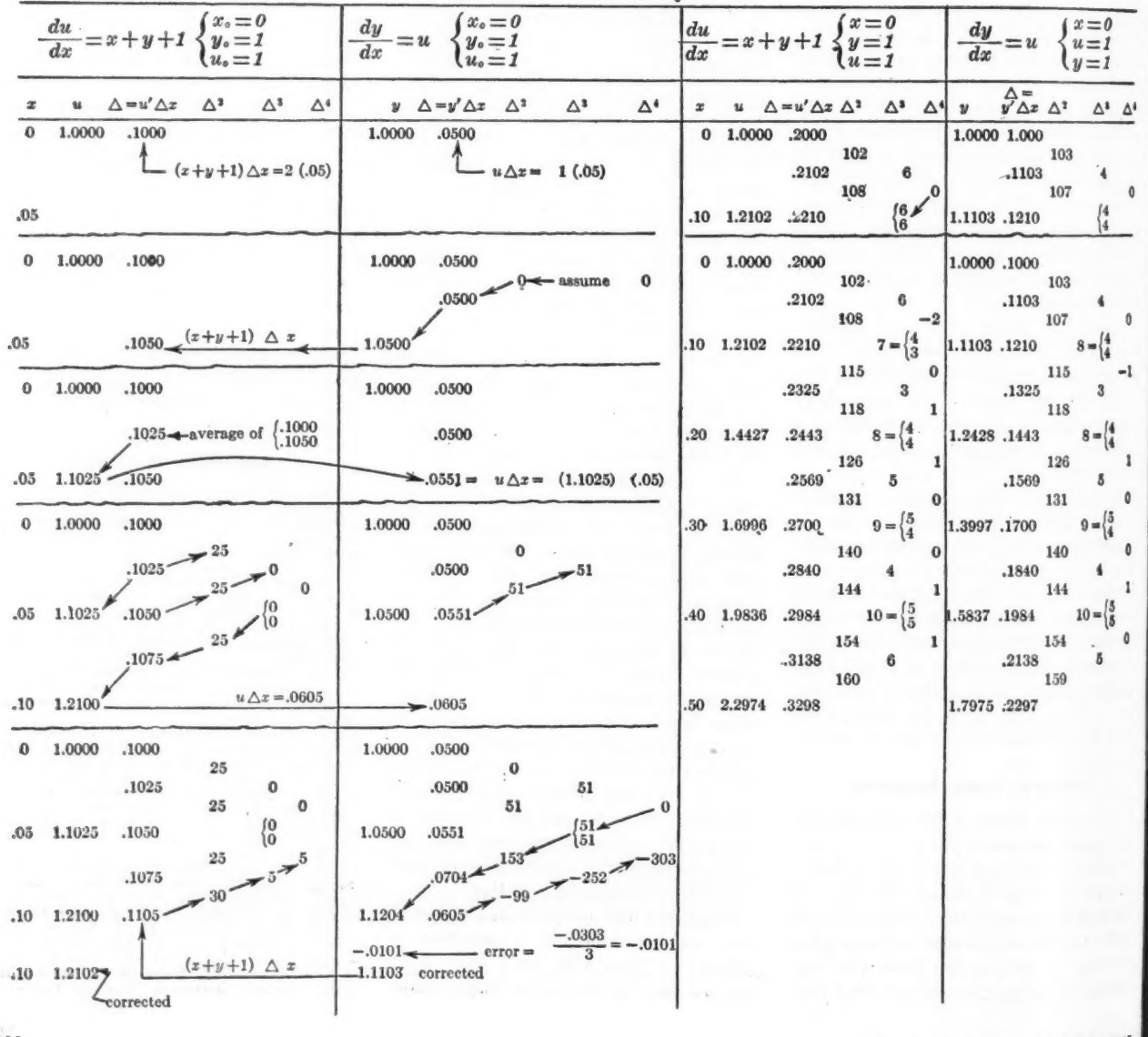
This is reduced to two first-order equations by substitution.

Thus:

$$\begin{cases} u = \dfrac{dy}{dx} & \begin{cases} x_o = 0 \\ y_o = 1 \\ u_o = 1 \end{cases} \\ \dfrac{d^2y}{dx^2} = \dfrac{du}{dx} = x + y + 1 \end{cases}$$

FIG. 11

Integration of $\dfrac{d^2y}{dx^2} = x + y + 1 \begin{cases} x_o = 0 \\ y_o = 0 \\ \left.\dfrac{dy}{dx}\right|_o = 1 \end{cases}$


du/dx = x+y+1 {x₀=0, y₀=1, u₀=1}
dy/dx = u {x₀=0, y₀=1, u₀=1}
du/dx = x+y+1 {x=0, y=1, u=1}
dy/dx = u {x=0, u=1, y=1}
x u Δ=u'Δx Δ² Δ³ Δ⁴
y Δ=y'Δx Δ² Δ³ Δ⁴
(x+y+1)Δx=2 (.05)
uΔx= 1 (.05)
assume 0
(x+y+1) Δ x
average of
uΔx = .0605
error = −.0303/3 = −.0101
corrected

Two difference tables are worked concurrently. The general rule is that one table is worked until an entry requires a value from the other table. The second table is then worked similarly. Each table complements the other as the example proceeds. This is shown in Fig. 11.

In many instances the value of variables may be found on curves for which there is no equation. These values may be used directly in the equation for the derivative, and the numerical integration table in used in the usual manner.

Following is a typical aircraft engineering problem involving a heat transfer design equation:

$$\frac{dT}{dx} = -0.25k\,U\,(T-20) \qquad \begin{matrix} T_o = 300 \\ x_o = 0 \end{matrix}$$

where k is a function of T, and U is a function of x. Curves for these functions are shown in Fig. 12, and the numerical integration thereof is shown in Fig. 13.

FIG. 12

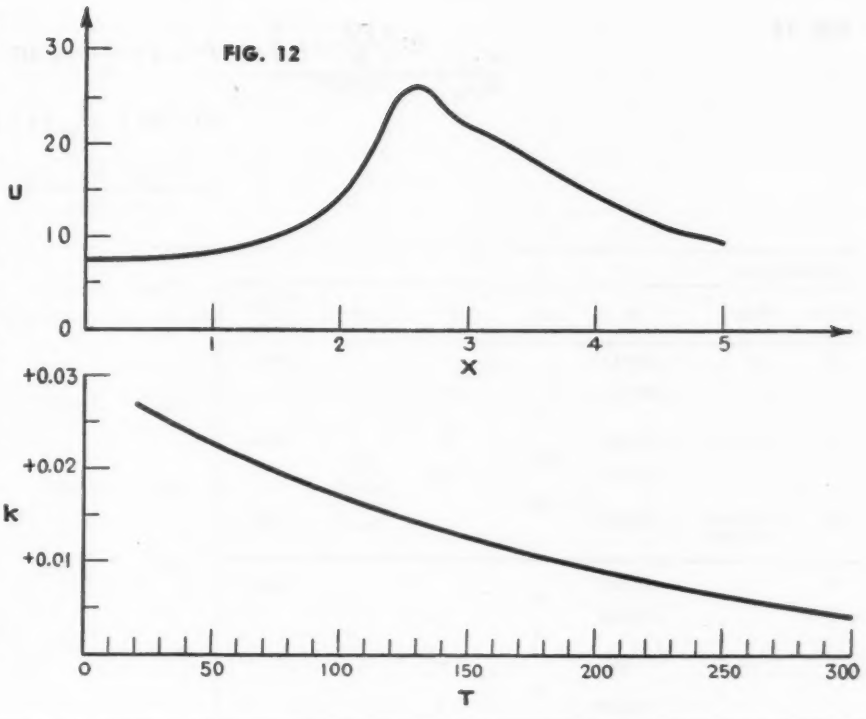


FIG. 13

Integration of $\frac{dT}{dx} = 0.25\,kU\,(T\text{-}20)$ $\begin{cases} x_o = 0 \\ T_o = 300 \end{cases}$

Find k & U values in figure 12
Try $\Delta x = .25$

x	T	Δ	Δ²	Δ³	Δ⁴	k	U	T-20	dT/dx
0	300.0	−4.9				+.0037	7.50	280	−19.4
						Δ =	−19.4	(.25)	= −4.9
0	300.0	−4.9							
			0						
		−4.9		−.2					
			−0.2		0				
.25	295.1	−5.1				+.0040	7.50	275.1	−20.6
						Δ =	−20.6	(.25) =	−5.1
0	300.0	−4.9							
			0						
		−4.9		−.2					
			−0.2		0				
.25	295.1	−5.1							
			−0.6		+1.0	T =	289.4	$+\frac{1.0}{3}$	=289.7
		−5.7		+0.8					
			+0.2						
.50	289.4	−5.5				+.0042	7.70	269.4	−21.8
0	300.0	−9.7							−19.4
		−10.3		Δx is now 0.50					
.50	289.7	−10.9							−21.8
0	300.0	−9.7							
			.6						
		−10.3		0					
			−.6		0				
.50	289.7	−10.9							
			−.6		−0.5	T =	278.2	$-\frac{.5}{3}$	= 278.0
		−11.5		−.5					
			−1.1						
1.00	278.2	−12.6				+.0047	8.3	258.2	−25.2
						Δ = −25.2		(.50) =	−12.6

x	T	Δ	Δ²	Δ³	Δ⁴	k	U	T-20	dt/dx
0	300.0	−9.7							
			−.6						
		−10.3		0					
			−.6		−.1				
.50	289.7	−10.9		−.2 = {−.1, −.1}					
			−.8		0				
		−11.7		−.1					
			−.9						
1.00	278.0	−12.6							

Process now continues by working a step, correcting it, and working another step until the desired limit is reached. The values which are in error are erased and correct ones written in.

0	300.0	−9.7							
			−.6						
		−10.3		0					
			−.6		−.1				
.50	289.7	−10.9		−.2 = {−.1, −.1}					
			−.8		0				
		−11.7		−.1					
			−.9		−.3				
1.00	278.0	−12.6		−.8 = {−.4, −.4}					
			−1.7		−.4	First trial T = 264.3			
		−14.3		−.8		error = $\frac{-1.9}{3}$ = −.6			
			−2.5		−.3	T = 264.3 − .6 = 263.7			
1.50	263.7	−16.8		−2.2 = {−1.1, 1.1}		+.0055	10.0	244.3	−33.6
			−4.7		−.3	+.0055	10.0	243.7	−33.5
		−21.5		−1.4					
			−6.1		−1.3	T = 242.8 error $\frac{-19}{3}$		First time	
2.00	242.2	−27.6		−5.4 = {−2.7, −2.7}		+.0070	14.2	222.8	−55.4
			−11.5		−1.4	+.0070	14.2	222.2	−55.1
		−39.1		−4.1					
			−15.6			First T = 205.7 error $\frac{-7.7}{3}$ = −2.6			
2.50	203.1	−54.7				+.0092	26.0	185.7	−111.0
						+.0092	26.0	183.1	−109.4
		−50.0							

The steps shown previously are for explanation purposes. The information shown below is the part usually written.

Since U is decreasing try −50.0 for Δ

3.00 153.1 ← First trial.

FIG. 14

$$\frac{dC_{P_o}}{dC_{P_M}} = \frac{M^2\left(\frac{FB}{M} - 1\right)}{AFB^2} \qquad F^n = 1 + \frac{n}{2} C_{P_M} M^2 \qquad M = .75$$

$$B^2 = M^2 + \frac{2}{n-1}(1 - F^{n-1}) \qquad n = 1.7 - .3\, C_{P_M}$$

$$A = \frac{\sqrt{1 - C_{P_o}} - 1}{1 - C_{P_o}} \qquad C_{P_o} = O \left.\right\} \text{Boundary} \quad C_{P_M} = O \left.\right\} \text{Conditions}$$

Starting table

C_{P_M}	C_{P_o}	Δ	Δ^2	Δ^3	Δ^4	$\frac{dC_{P_o}}{dC_{P_M}}$
0	0	−.006614				.6614
		−.006614	—			
			78	78		
				78	0	
−.01	−.006614	−.006566		78		.6566
			234		−616	
		−.006332		−538		
			−304		−205 error	
−.02	−.012946	−.006636				.6636
	−.000205					

0	0	−.01323				.6614
			8			
		−.01315		0		
			8		0	
−.02	−.01315	−.01307		$0 = \begin{cases} 0 \\ 0 \end{cases}$		.6566 −
			8		1	
		−.01299		1		
			9		−1	
−.04	−.02614	−.01290		$-1 = \begin{cases} 0 \\ -1 \end{cases}$		.6449 +
			8		1	
		−.01282		0		
			8		0	
−.06	−.03896	−.01274		$0 = \begin{cases} 0 \\ 0 \end{cases}$		.6368
			8		1	
		−.01266		1		
			9		−1	
−.08	−.05162	−.01257		$0 = \begin{cases} 0 \\ 0 \end{cases}$		.6283
			9		−1	
		−.01248		−1		
−.10	−.06410	−.01240	8			.6200 −

C_{P_M}	C_{P_o}	Δ	Δ^2	Δ^3	Δ^4	$\frac{dC_{P_o}}{dC_{P_M}}$
0	0	−.0661				.6614
			20			
		−.0641		1		
			21		0	
−.10	−.0641	−.0620		$1 = \begin{cases} 1 \\ 0 \end{cases}$		.6200
			22		1	
		−.0598		1		
			23		0	
−.20	−.1239	−.0575		$1 = \begin{cases} 1 \\ 0 \end{cases}$		.5756
			24		0	
		−.0551		0		
			24		1	
−.30	−.1790	−.0527		$2 = \begin{cases} 1 \\ 1 \end{cases}$		.5271
			26	1	0	
		−.0501				
			27		0	
−.40	−.2291	−.0474		$2 = \begin{cases} 1 \\ 1 \end{cases}$		.4738
			29	2	1	
		−.0445				
			31		−1	
−.50	−.2736	−.0414		$2 = \begin{cases} 1 \\ 1 \end{cases}$		.4142
			33	1	0	
		−.0381				
			34		1	
−.60	−.3111	−.0347		$4 = \begin{cases} 2 \\ 2 \end{cases}$		.3488
			38	3	1	
		−.0309				
			41		0	
−.70	−.3420	−.0268		$5 = \begin{cases} 3 \\ 2 \end{cases}$		.2676
			46	3	1	
		−.0222				
			49		1	
−.80	−.3642	−.0173		$8 = \begin{cases} 4 \\ 4 \end{cases}$		.1729
			57	4	0	
		−.0116				
			61		0	
−.90	−.3758	−.0055		$9 = \begin{cases} 4 \\ 5 \end{cases}$		.0553
		+.0015	70			

In a study of compressibility, it became necessary to integrate the following equation:

$$\frac{dC_{P_o}}{dC_{P_M}} = \frac{M^2\left(\frac{FB}{M} - 1\right)}{AFB^2}, \text{ where}$$

$$A = \frac{\sqrt{1 - C_{P_o}} - 1}{1 - C_{P_o}}$$

$$B^2 = M^2 + \frac{2}{n-1}(1 - F^{n-1})$$

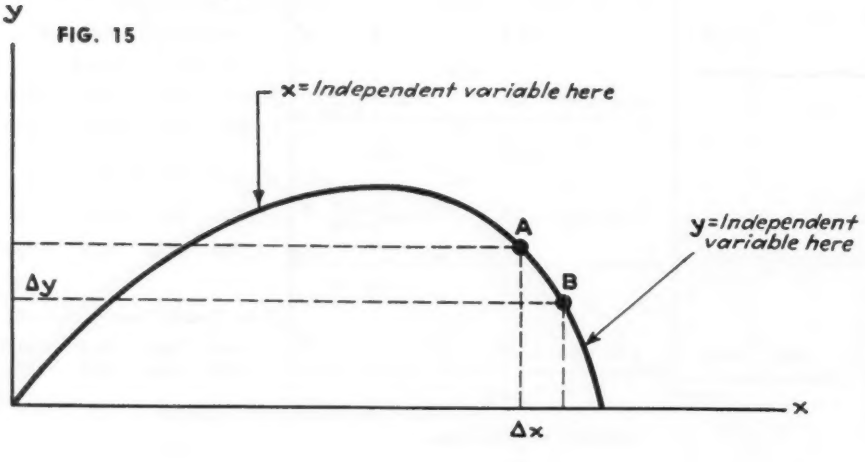
$$F^n = 1 + \frac{nM^2}{2} C_{P_M}$$

$$n = 1.7 - .3\, C_{P_M}$$

Initial conditions are:

$$C_{P_o} = 0,\ C_{P_M} = 0,\ \frac{dC_{P_o}}{dC_{P_M}} = \sqrt{1 - M^2}$$

FIG. 15



This equation is fairly easy to integrate by the difference-table method. Procedure of starting the integration is slightly irregular, because small changes in the variables make appreciable changes in the derivative. This necessitates the use of very small increments in starting the table. C_{P_o} is chosen as the dependent variable and C_{P_M} is then used as the independent variable. There are three factors in the equation which consist of the difference of two items of nearly the same value:

$$(\sqrt{1 - C_{P_o}} - 1),\ \left(\frac{FB}{M} - 1\right), \text{ and } (1 - F^{n-1})$$

when $C_{P_M} >> 0$. For this, at least seven figure computations are required. The integration is shown in Fig. 14.

The accuracy which can be obtained by numerical methods is dependent upon the size of Δx. Greater accuracy requires a smaller value of Δx, and makes more work in covering the same range in x. It is usually better to select Δx too small, rather than too large, in starting the integration. The value of

Δx can be increased at any time after the integration is started by merely selecting two desired x-values and their corresponding y values, tabulating these as entries in a new portion of the table. On the other hand, a reduction in Δx requires that an entirely new start be made.

In some equations, a very small change in x produces a large change in y. In such case, the accuracy is improved if the variables are interchanged and Δ is made $dx/dy\ \Delta y$. In one case in the author's experience, the variables were interchanged when part way through the needed integration. Two adjacent tabulated values were chosen near to the point where $dy/dx = 1$. After the switch, the value of Δy was not a simple decimal number, but the idea solved the problem. The curve was similar to the one in Fig. 15.

Most reference books which devote a chapter to numerical integration make the mistake of illustrating the classical or iteration method of successive approximations. In most cases, the solution is a matter of numerical integration accomplished by the analytical methods.

A splendid discussion of the value of numerical integration is given by James B. Scarborough in his *Numerical Mathematical Analysis*. It reads in part as follows:

"Suppose the equation $dy/dx = (y-x)/(y+x)$ is given, with initial conditions $x_o = 0$, $y_o = 1$, and it is required to find several corresponding values of x and y. The given equation can be solved by putting $y = vx$. The result is:

$$\tfrac{1}{2}ln\,(x^2 + y^2) + \tan^{-1}\left(\frac{y}{x}\right) = \frac{\pi}{2}$$

To find pairs of corresponding values of x and y from this equation, we could substitute the desired values of x and then solve the resulting equation for y. But this resulting equation will always be a complicated transcendental equation which can be solved only by trial—by Newton's method or otherwise. The labor of solving this equation for even a single value of y would probably be as great as that of computing several tabular values by numerical integration."

Finally, our Fig. 16 shows integration of the above equation. The small value for Δx makes it possible to compute $y'\,\Delta x$ with a slide rule. The tabulated values are quickly calculated. As a check on the accuracy, take the values when $x = 1$, $y = 1.4977$, and substitute in the equation:

$$ln\,(x^2 + y^2) + 2\tan^{-1}\frac{y}{x} = \pi$$

$$ln\ 3.243 + 2\tan^{-1} 1.4977 = 1.177 + 1.964 = 3.141$$

When $x = 2$, $y = 1.5189$, we find the following:

$$ln\,(x^2 + y^2) + 2\tan^{-1}\frac{y}{x}$$

$$= ln\ 6.3071 + 2\tan^{-1} .75945 = 3.1411$$

FIG. 16 *Integration of* $\dfrac{dy}{dx} = \dfrac{y-x}{y+x}$ $\begin{cases} x_o = 0 \\ y_o = 1 \end{cases}$

x	y	Δ	Δ^2	Δ^3	Δ^4
0	1.0000	.0250			
			0		
		.0250		−12	
			−12		0
.025	1.0250	.0238		−24 {−12 −12}	
			−36		+73
		.0202		+61	
			+25		
.05	1.0452 25	.0227			
.05	1.0477				
0	1.0000	.0500			
			−23		
		.0477		+1	
			−22		0
.05	1.0477	.0455		2 = {1 1}	
			−20		0
		.0435		1	
			−19		0
.10	1.0912	.0416		2 = {1 1}	
			−17		0
		.0399		1	
			−16		0
.15	1.1311	.0383		1 = {1 0}	
			−15		1
		.0368		1	
			−14		
.20	1.1679	.0354			

It appears that Δx may be increased. Do this by tabulating the value for x = 0, .10 and .20 in the column to the right

x	y	Δ	Δ^2	Δ^3	Δ^4
0	1.0000	.1000			
			−88		
		.0912		7	
			−81		1
.10	1.0912	.0831		15 = {8 7}	
			−66		−1
		.0765		6	
			−60		−2
.20	1.1679	.0708		8 = {4 4}	
			−52		0
		.0656		4	
			−48		−1
.30	1.2333	.0608		6 = {3 3}	
			−42		−1
		.0566		2	
			−40		0
.40	1.2899	.0526		4 = {2 2}	
			−36		0
		.0490		2	
			−34		−1
.50	1.3389	.0456		2 = {1 1}	
			−32		1
		.0424		2	
			−30		−1
.60	1.3813	.0394		2 = {1 1}	
			−28		0
		.0366		1	
			−27		0
.70	1.4179	.0339		1 = {1 0}	
			−26		1
		.0313		1	
			−25		−1
.80	1.4492	.0288		1 = {0 1}	
			−24		1
		.0264		2	
			−22		−1
.90	1.4756	.0242		1 = {1 0}	
			−21		0
		.0221		0	
			−21		0
1.00	1.4977	.0200		0 = {0 0}	

x	y	Δ	Δ^2	Δ^3	Δ^4
1.00	1.4977	.0200		0 = {0 0}	
			−21		1
		.0179		1	
			−20		0
1.10	1.5156	.0159		1 = {1 0}	
			−19		0
		.0140		0	
			−19		0
1.20	1.5296	.0121		1 = {0 1}	
			−18		−1
		.0103		0	
			−18		0
1.30	1.5399	.0085		0 = {0 0}	
			−18		1
		.0067		1	
			−17		−1
1.40	1.5466	.0050		0 = {0 0}	
			−17		0
		.0033		0	
			−17		0
1.50	1.5499	.0016		1 = {0 1}	
			−16		0
		.0000		0	
			−16		0
1.60	1.5499	−.0016		0 = {0 0}	
			−16		1
		−.0032		1	
			−15		−1
1.70	1.5467	−.0047		0 = {0 0}	
			−15		−1
		−.0062		−1	
			−16		1
1.80	1.5405	−.0078		1 = {0 0}	
			−15		−1
		−.0093		0	
			−15		0
1.90	1.5312	−.0108		0 = {0 0}	
			−15		1
		−.0123		1	
			−14		
2.00	1.5189	−.0137			

EVALUATING THE VAUNTED V-2

By WILLY LEY, *Formerly Vice-President, German Rocket Society*

Here's a revealing analysis of this rocket-weapon's intriguing technical aspects, its war-worth, and its importance as a transitional factor in aerial research.

SUCH EXTREME SPECULATION was aroused concerning an RAF Bomber Command operational flight during the night of Aug. 17–18, 1943, that Prime Minister Churchill reported on the nature of the air attack to the House of Commons.

It had been an unusually heavy blow, yet had been directed against an obscure fishing village—Peenemünde on the Baltic, situated at the extreme northwest tip of the Island of Usedom, the westerly of two islands sheltering the Bay of Stettin.

Churchill then disclosed that the Nazis had built a large research laboratory near Peenemünde, which had been "the main experiment station both of the flying bomb and the long-range rocket." The report had it that the laboratory was virtually destroyed in the attack, with 5,000 of its 7,000 scientists and technicians killed.

The flying bomb mentioned by Churchill is the now well-known V-1, essentially a jet-propelled robot-directed flying torpedo, carrying a warhead of 1,000 kg., that is, 2,200 lb.

Churchill's mention of the long-range rocket was the first official confirmation that there was a kernel of truth in the innumerable rumors then extant.

But the long-range rocket, now known as V-2, failed to materialize for a considerable length of time. In spite of all rumors and so-called eye-witness reports, in spite even of Churchill's reference to such a weapon, it seemed to many observers as if V-2 were merely a Nazi propaganda claim, or, at best, an experiment that had miscarried.

But after some of the V-1 bases were captured by the Allied armies, easing the stress on England from these 150-mi.-range weapons, the long-range rocket did materialize. On Nov. 10, 1944, Churchill, in another report to the House of Commons, stated that V-2 rockets had been falling on England for "several weeks", landing "at widely scattered points."

In discussing V-2 it is necessary to consider its various aspects separately, since proper evaluation of the importance of this invention is otherwise impossible. V-2 can be considered as a weapon creating terror, tied up with propaganda and psychological warfare; on the other hand, it can be studied simply as a rocket.

Considered as a weapon, V-2 is comparatively ineffectual and there is reason to doubt whether a long-range rocket bombardment would ever be an effective means of assault, even if regarded only as a substitute for air bombardment.

Considered as a terror or propaganda weapon its chief value is that it strikes without warning. Another aspect of terror value is, peculiarly, that V-2 is not accurate. Under conventional air bombardment, populations living at a distance from railroad yards, bridges, junctions, airports, factories, and power plants know they are relatively safe. Long-range rockets, however, may terrorize large sections of such populations because they are just as likely to crash on a stretch of land devoid of any military target as to fall on or near a vital objective.

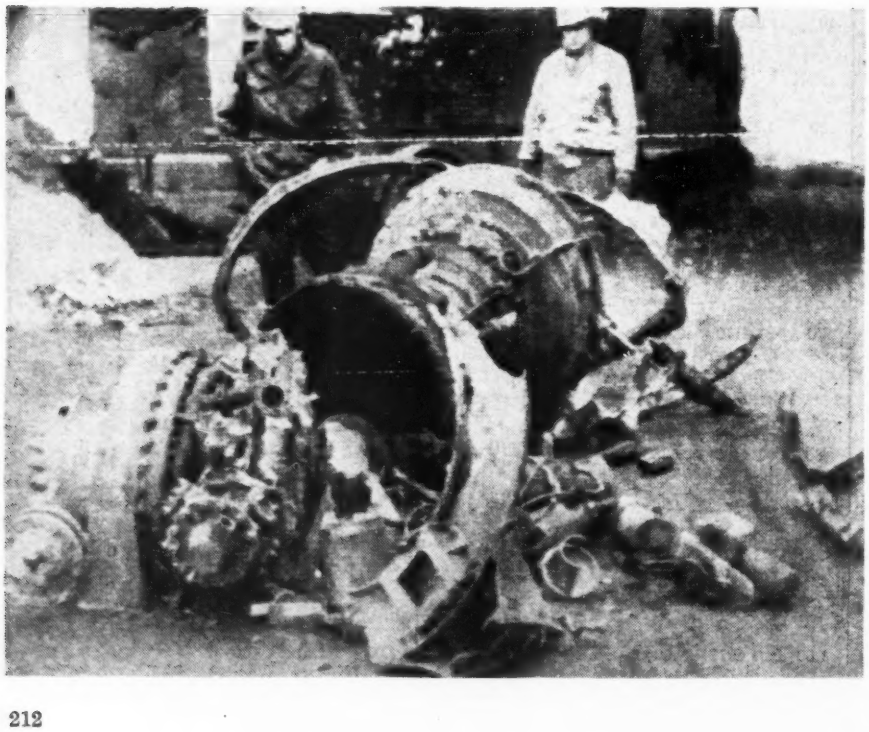
But because populations of warring countries have become somewhat hardened to air attack—whether by bomber, flying bomb, or rocket—the terror value of the V-2 type of weapons is hard to estimate. Since actual damage and loss of life resulting from long-range bombardment is small, the psychological attitude of the population is conjectural. The reasonable conclusion, at present, is that V-2 still has to prove that its value as a terror or propaganda device is worth the expenditure.

Considered, however, in the light of rocket research and engineering in general, V-2 must be acclaimed a masterpiece. Enemy development or not, *V-2 represents one of the greatest technological advances made during the last two decades.*

It is advisable to admit this for our own good, especially since on this side of the water we have, in the past, generally displayed remarkable persistence in neglecting the value, or even the existence, of rocket research.

V-2 is a development which opens limitless possibilities, especially so since its performance is in incredibly close agreement with rocket theory as it was developed before liquid-fuel rockets even existed. V-2 can, therefore, be regarded as large-scale experimental proof for the general validity of rocket theory and also as encouragement that other predications of rocket theory may

Some of mechanical-makings of Nazi high-flying supersonic-speed V-2 rocket bomb are revealed in this shot of wreckage found in Belgium. Seen in front of combustion chamber and venturi are parts of turbine and pump assembly. (Associated Press photo)



me true with added experimentation. The fundamental conceptions required to understand rocket theory are: first, the rôle and importance of the haust velocity (c) and its relationip to the velocity (v) of the rocket; nd second, the conception of the massatio which expresses this relationship.

The rocket principle consists of ovement in accordance with Newton's hird Law of Motion, by the reaction f a continuous jet of gases produced y continuous combustion of fuel. The xygen required for fuel combustion is ot derived from the air during flight ut is taken along in the form of a soalled carrier—the most efficient being quefied oxygen.

In fireworks and projectile rockets, he fuel is a compressed powder mixre containing the oxygen, required or combustion, in the form of chemical ompounds. The disadvantage of owder rockets is that the "combustion hamber" and "fuel tank" are one and he same. This not only limits the mount of fuel which can be efficiently arried, but it also leaves the designer ith no safeguard against premature xplosion other than the compactness f the compressed powder designed to ermit burning only at its surface.

In liquid-fuel rockets, combustion hamber and fuel tanks are separate nits so that only the fuel and oxygen ed into the combustion chamber unite hemically.

It is obvious that the rocket velocity (v) increases with an increase in exhaust velocity (c); also that a rocket with longer burning time will attain a higher v than a rocket with a shorter burning time, although c and the thrust (P) are given and are the same in both cases.

Factor c is supplied by the nature of the fuel, assuming that the design of the rocket motor is reasonably efficient. The accompanying Table I shows, for a number of fuels the theoretical values for c and the values which may be reasonably expected.

Whereas fireworks and projectile rockets utilize powder mixtures, V-2 is known to burn alcohol and liquid oxygen. The choice of alcohol instead of gasoline is a matter of practical consideration—1 lb. of alcohol needing 2.1 lb. of liquid oxygen for complete combustion, while 1 lb. of gasoline requires 3.5 lb. of liquid oxygen.

Exhaust velocity for alcohol-oxygen, attained with V-2, seems to be about 2,000 m. per sec., or roughly, 6,550 ft. per sec. The significance of this value for c will become apparent when mass-ratio has been discussed.

The mass of the rocket at takeoff, when both the fuel and oxygen tanks are still full, is usually called M_o and the mass after all fuel has been consumed is termed M_1. In turn, M_1 equals $M_P + M_R$—"payload" and the empty rocket, respectively. The mass-ratio is M_o/M_1, and for all fireworks and projectile rockets the numerical value of this expression is only slightly greater than 1.

TABLE I—Theoretical and Expected Values of Exhaust Velocity (c) for Various Fuels

Fuel	c—theoretical (m./sec.)	c—expected (m./sec.)
Black powder	2,420	900–1,000
Smokeless powder	3,240	1,500–1,800
Dynamite	3,300	(?)
Gasoline + liquid oxygen	4,450	2,000–2,500
Gasoline + liquid ozone	4,960	2,500–3,000
Alcohol + liquid oxygen	4,180	2,000–2,500
Alcohol + liquid ozone	4,630	2,500–3,000
Hydrogen + liquid oxygen	5,170	3,500–4,000
Hydrogen + liquid ozone	5,670	4,000–4,500

Note: No experiments with liquid ozone have been made because of its instability. Hydrogen is difficult to handle because of its extremely low boiling point but control would be mostly a matter of practice.

The thrust P of a rocket has to be greater than M_o, since the rocket obviously could not rise if the thrust developed by the rocket motor were less than the weight of the rocket. P is determined by the value for c in a given case and by the amount of fuel consumed during a given interval of time. The formula, then, reads:

$$P = c \times dm/dt$$

Since the molecules of the exhaust may be considered infinitesimal as compared to the mass of the rocket, it is permissible to use the expression—

$$v = c \times \text{lognat } M_o/M_1$$

for the relationship between v and c. Consequently $v = c$ when $M_o/M_1 = e$, so that it is possible to arrive at a general formula for the interdependence of v, c, and M_o/M_1 by writing—

$$M_o/M_1 = e^{v/c}$$

It is this formula which permits determining the mass-ratio requirements for a desired performance, and it is of great interest to compare actual artillery performance with hypothetical rocket performance derived from this formula.

Three cases, which may serve as examples of such comparisons are given in Table II.

If the same weight of shell were to be transported over the same range by means of rockets, we would find the required mass-ratios given in the following paragraphs. (It was assumed for these calculations that the rocket is a powder rocket with a propelling charge delivering $c = 900$ m./sec. For simplicity, the muzzle velocity of the gun and the greatest velocity of the rocket at the instant when all fuel has been consumed were considered equivalent. Actually, a rocket would have traveled some distance when that velocity is attained.)

TABLE II—Examples of Artillery Performance

	Weight of shell (kg.)	Weight of propelling charge (kg.)	Range attained (km.)	Muzzle velocity (m./sec.)	Gun used
Case I.	118	1.135	0.600	90	(French 220 mm. mortar model 1887)
Case II.	118	6.126	3.200	230	Same
Case III.	120	300.0	126.0	1,500	(German *Paris Gun* Mar. 1918)

Case I would require a mass-ratio of approximately 1.15. M_1 would be M_P (118 kg.) + M_R (12 kg.), and M_o would be $M_1 \times 1.15$, or 149.5 kg.

Case II would require a mass-ratio of $e^{1/3}$ or about 1.4. M_R would have to be somewhat greater because of this higher mass-ratio, so that M_1 would be, say, 135 instead of 130 kg. M_o would then be 189 kg.

Case III would require a mass-ratio of $e^{1.75}$ or $e^{7/4}$, which amounts to approximately 5.76. For such high mass-ratio, M_R would at least have to be equal to M_P so that the lowest possible value for M_1 would be 236 kg. M_o would assume a value of 1,360 kg—meaning that a rocket would require a powder charge of 1,124 kg. for the same weight of shell, and the same range which the gun could handle with an expenditure of 300 kg. of powder.

Despite this difference, a rocket might be preferable from point of view of financial expenditure. Guns are expensive, rockets comparatively inexpensive, and powder is cheap. The rocket would involve more weight of materials, but less in cash.

But because of engineering considerations mentioned earlier, it is doubtful whether a mass-ratio higher than 1.5/1 would ever be employed with powder used as fuel. When liquid fuels are taken into consideration, a different picture is presented. Liquid fuels not only yield much higher values for c (roughly twice as much), but also permit much higher mass-ratios.

In experimental liquid-fuel rockets of relatively small size, it is customary to force the liquid from the fuel tanks into the combustion chamber simply by the use of compressed nitrogen. This permits mass-ratios of 2/1 and 2.5/1 but hardly beyond that, since the fuel tanks are necessarily heavy in order to withstand the internal pressure used to force the liquids into the rocket motor.

If higher mass-ratios are desired, it is necessary to provide a pumping mechanism which can force the fuel into the combustion chamber from low pressure tanks which are just strong enough to hold the fuel, and are, consequently, rather light. The problem is, of course, to build the pump and pump drive sufficiently light so that introduction of the unit results in a saving in weight.

It is likely that, to do the job, such

pumping mechanism would have a minimum size limitation—and as a weight-saving device it could be applied only to large rockets. In V-2, the designers seem to have utilized two centrifugal pumps driven by a gas turbine fed from the same fuel tanks which feed the rocket motor.

This required a large scale design coupled with a high mass-ratio because of the speed this rocket had to attain to span the desired range.

V-2 is generally cigar shaped, with a warhead, of the same weight as that of V-1, forming the nose. The alcohol tank is located behind the warhead—below it if we imagine the rocket upright. The oxygen tank is below the alcohol tank and the pumping mechanism is below the oxygen tank. The motor is in the bottommost part of the rocket, and various auxiliary devices are grouped around the upper part of the motor and around the pump. These auxiliary devices consist in the main of means to control the vanes which keep the rocket ascending at an angle. If there were just rigid stabilizers, the rocket would tend to deviate from the angle at which it was fired, and approach the vertical.

Performance of V-2, according to British sources, includes a range close to 300 mi. with peak altitude of about 70 mi. Most of the trajectory is located in high-altitude media so rarefied that there is an approach to a good laboratory vacuum. Because of this, V-2 approaches so-called ideal conditions in elementary ballistics, wherein formulas state that the maximum range for a given gun will be attained when it is fired with an elevation of 45 deg. In such case, the range is v^2g, and the peak altitude along the trajectory is $v^2/4g$; in other words, range equals four times maximum altitude.

Since these formulas neglect air resistance, they never actually hold true, except with some pieces of trench artillery where the shell is so heavy and the muzzle velocity so low that air resistance is less than the gunner's error in estimating the distance to the target.

Because more than 90 percent of V-2's trajectory is located in near-vacuum these elementary formulas are almost applicable. With the maximum range being just about four times the peak altitude, it is likely that V-2 is fired at an angle of 45 deg. or slightly more. (The Paris Gun of 1918 had an 80-mi. range mainly because the greater portion of the trajectory was in highly rarefied strata. Utilizing this feature, the designers did, in fact, call for firing of the gun at an elevation of 54 deg. in order that the shell would more rapidly leave the denser layers of the atmosphere. The 54 deg. elevation actually produced a longer range than did the 45 deg.)

V-2 Values

With V-2, M_P is 1 metric ton, M_R is probably the same, and therefore M_1 may be assumed to be 2 metric tons. Mass-ratio for the range actually spanned would have to be 6/1—bringing M_0 to 12 metric tons, assuming c to be 2 km./sec. Reports from Germany and England state that the takeoff weight of V-2 is 12-15 tons, which is in substatic agreement with theoretical figures.

Having a reasonable assumption of the value of c and knowing the mass-ratio, it is easy to calculate some other features. Reported dimensions—length of about 45 ft. and maximum diameter of about 15 ft.—agree well with the known weight and the average density, which cannot be much greater than 1.1 or 1.2.

The fuel load of 10 metric tons must be apportioned as 3¼ tons for the alcohol and 6¾ tons for the liquid oxygen. The thrust of the rocket motor is probably 18,000 kg.—about 40,000 lb., producing an initial acceleration of 0.5 g, which is probably the lower limit required for reasons of stability. With P=18,000 kg. and c=2,000 m/sec., the fuel consumption per sec. must be 90 kg.— about 200 lb.

Since it is likely that the fuel consumption is constant, being probably equal to the maximum capacity of the fuel pumps, the maximum burning time ($T_{max.}$) will be 111 sec., and because c is constant the thrust will remain the same throughout this interval of 111 sec. But the rocket weight is decreasing steadily (at the rate of 90 kg. per sec.) so that P/M is increasing steadily, covering any value between 0.5 g and 8 g, referring to the *effective* acceleration.*

It would be possible to increase the range of V-2 by increasing the mass-ratio or the exhaust velocity, or both. The easier method is to increase the mass-ratio—accomplished most easily by reducing the weight of the warhead. But slashing the weight of the warhead to half a ton would not double the mass-ratio, as may be thought at first glance—$M_1=M_P+M_R$, and the value for M_R would remain unchanged. Doubling the mass-ratio would necessitate discarding the warhead!

An impressive increase of mass-ratio (and range) could be accomplished by replacing the warhead with a 1-ton rocket of similar mass-ratio, provided that the pumping mechanism can be built small enough. If that could not be done, this smaller rocket could at best have a mass-ratio of 3/1 instead of 6/1. But even such lower mass-ratio for the smaller rocket would still result in a total range of 500-550 mi. The warhead would then weigh only 300-350 lb., and such a "step rocket" would be even less accurate than a single rocket.

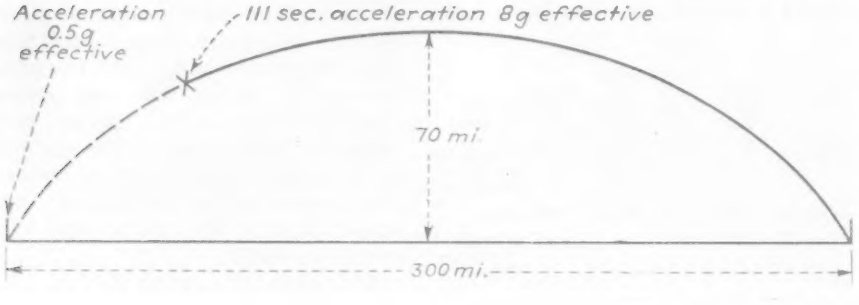
However, if a step rocket of the total size of V-2 were fired vertically, the upper step, with a "payload" of from 300-350 lb., would reach a total altitude of approximately 400 mi.—which means it would touch interplanetary space. And a payload of 300-350 lb. could accommodate a substantial number of self-recording scientific instruments—and even, hypothetically, a human observer.

This certainly is the real importance of V-2.

As a war weapon V-2 is quite ineffectual—as could be predicted on theoretical grounds—and propaganda value is doubtful. But V-2 has demonstrated that liquid-fuel rockets of mass-ratio of about 6/1 can be built *now*; that the problem of the fuel pump can be solved; and that rocket motors with a fuel consumption of 90 kg./sec. and thrust of 18,000 kg. plus, are possible.

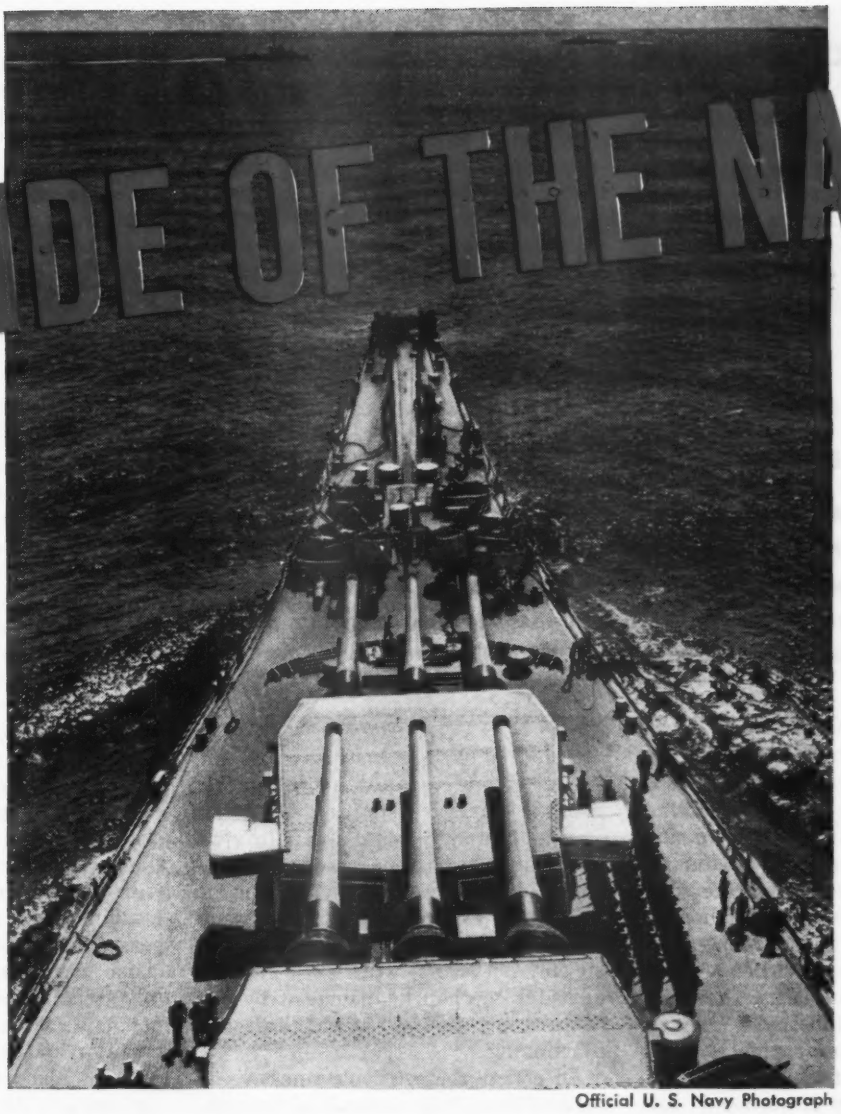
And there is little doubt that such a rocket can be a research instrument of decided value.

Probable trajectory of V-2. Initial dash-line indicates ascent under power.



* A report received from England since the foregoing calculations were completed, gives 55 deg. as the angle at which V-2 is fired so as to quickly penetrate the dense layers of atmosphere. The rocket is tilted slowly while ascending, attaining an angle of 45 deg. for maximum range at about 12 mi. The report assumes an effective acceleration of 1 g at take off, which requires a thrust P=36,000 kg.—about 80,000 lb. The rate of fuel consumption, consequently, is assumed to be about 400 lb./sec. Burning time, however, is given as 71 sec. (instead of 55.5 sec.). Presumably a mass-ratio slightly greater than 6:1 was assumed by the British computers.

PRIDE OF THE NAVY



Official U. S. Navy Photograph

JUSTLY proud of its fighting officers and enlisted men, the Navy is equally proud of its giant 16-inch rifles that can hurl a 2200-lb. shell 20 miles with deadly accuracy. Most precise of many operations involved in machining these guns — cutting the rifling — is performed by an intricate 48-tool rifling head that makes 750 passes through the bore to complete 96 spiral grooves in the liner.

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TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

What Makes Expert Mechanics EXPERT?

PART I OF A SERIES

By E. F. LINDSLEY

Emphasizing that yesterday's "tune 'em by ear" boys are now "out," the author carefully charts today's engine maintenance field to show what modern requirements demand of a man . . . First of a group of lucid articles detailing the various exacting phases of engine service and overhaul.

OF THE THREE aircraft engine maintenance divisions — line maintenance, trouble shooting, and overhaul—the first two probably are not as cleanly divided as our accompanying chart would indicate. For line maintenance and trouble shooting frequently overlap. Line maintenance is shown in the chart as comprising routine line checks, replenishment of fuel and lubricants, and replacement of the more rapidly wearing parts, such as sparkplugs. Also included are accessory adjustments, particularly on new, or recently overhauled, engines.

Second maintenance category, usually termed "trouble shooting", includes corrective measures after trouble is located and requires well integrated knowledge of the engine, plus much patience.

A decade or more ago the so-called "top overhaul" was accepted practice in nearly all power ranges, since it was believed that the actual power producing units—cylinders, valves, rings, etc. —were prone to wear more quickly than the power transmitting system, or crankshaft and gearing. Metallurgical and design progress has, however, eliminated to a large extent the need for top overhaul. The result is that the modern engine mechanic is called upon to do only occasional work on a cylinder or valve mechanism damaged by improper operation or mechanical misfunctioning.

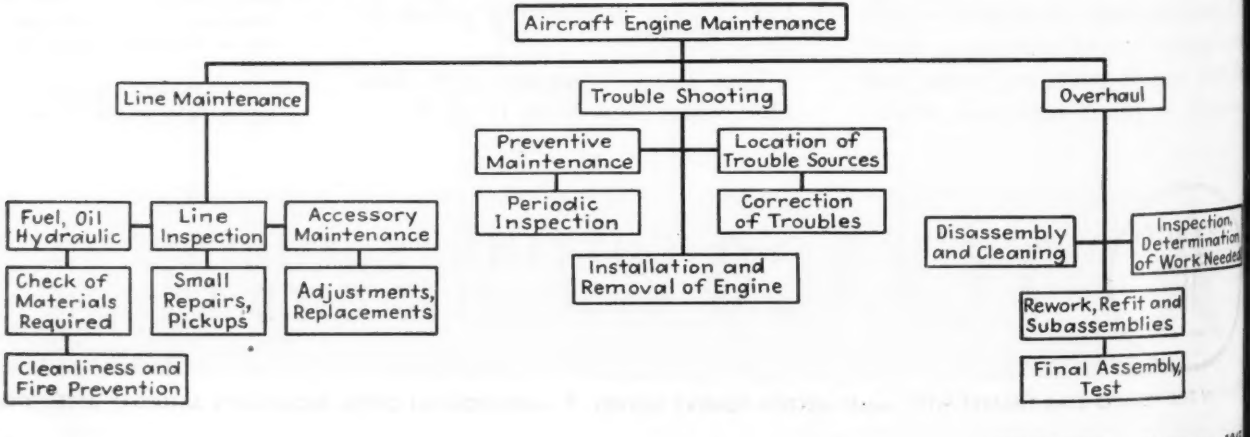
Of course these trouble sources will be with us as long as mankind uses machines; their existence does not discredit either the designers or producers of our excellent present-day engines.

In the higher power ranges used in current aircraft, engine overhaul divides itself clearly from the two foregoing types of maintenance. It has not been unusual in the light plane class for a mechanic to tear down an engine in the hangar, using only a small complement of hand tools, perform a rather generalized overhaul, and rebuild the engine so that it operates quite successfully. But the author believes that the trend will be away from this sort of thing after the war. Overhaul will then be accomplished by licensed repair stations or factory shops, with precision equaling that now bestowed on the larger engines.

Today's expert engine overhauler differs decidedly from the tanned young flyer-mechanic previously mentally pictured as diagnosing power plant malfunctions with the proverbial practiced ear. Now, your average overhaul mechanic is, and will be, represented by the grizzled, tool-maker type machinist with years of experience in precision machine shop work and with a mind geared to a micrometer vernier. Precision mechanical work also gives rise to specialization, both from the economic viewpoint of the repair station operator and from the technical viewpoint of concentration of skill for quality work. A man must become an expert.

No mechanic can inspect many different parts of varied makes and models of engines at irregular intervals and still be a truly competent inspector; genuine inspection skill is arrived at by inspecting after service the same type parts in a large number of similar engines. Thus the inspector learns to know what to look for, where to look for it, and what must be done to rework used parts into such good

This diagram details three prime phases of maintenance and depicts their relation.



ondition that they may be re-used.

We have now distinguished at least hree divisions of this work which may e termed equally important. Not mentioned as yet are the more or less pecialized maintenance in propeller, ccessory, and instrument overhaul. Truly, a man who professes to be qually competent "on the line", shooting and correcting troubles, overhauling engines, maintaining propellers, nd adjusting accessories, is biting off a arge mouthful.

Flight-Line Maintenance

No job that affects the operation of n airplane may be considered so trivial as not to require specific technical nowledge. Even the line mechanic who pulls out the chocks and signals "all clear" to the pilot assumes responsibility both for his own work and that of his co-workers.

If the line mechanic is called upon for nothing more than routine replenishing of fuel and oil, his job log may read "Serviced airplane #2 with 50 gal. 100-octane gas and 2 gal. #120 oil." Essentially, he did exactly that—supplied the ship with gas and oil.

With true service in mind, however, a *competent* line mechanic would probably accomplish several other things while in the simple process of replenishing.

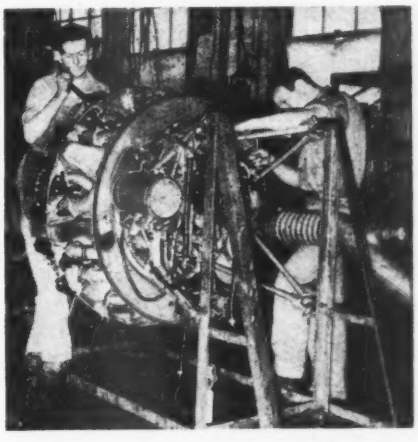
Let us watch this experienced mechanic supplying a plane with oil and gasoline—

As he walks to the plane he notes the make and model of the engine, mentally thumbs through his file of information, remembers that this engine requires 100 octane fuel, and then checks to be sure. This would require moving the plane down the line to the 100-octane gas pit. Likewise this mechanic notes miscellaneous details, such as trim and adjustment of oleo struts, tire inflation and condition, oil and grease leaks around the cowling, propeller and fuselage. And now, going out front, he tugs on the cowl and observes the fasteners to see if the cowling is properly secure. Such tugging affords a helpful check, provided it is done with enough strength to equal the air forces acting on the cowling in flight.

Practice will develop the powers of observation to a remarkable degree. Mechanics who appear to give no more than a glance at an engine often have noted numerous minor troubles, such as loose hose clamps, improperly safetied fastenings, and failing fittings. This flash technique is not recommended for routine inspections, which should be performed with minute care.

However, a man placing gas and oil in a ship is not on a routine inspection. Here, the secret lies in also observing each individual item and group of items for a fraction of a second. Everyone has had the experience of staring at a printed page without focusing attention on the words. When regarded thus, the writing is meaningless, yet, when one gives concentrated attention to each word for a fraction of a second, staring becomes reading. So may an observant mechanic "read" an engine.

Next comes the job of starting the engine and taxiing the plane to the 100-octane pit. Here, the following considerations are paramount for disregard of them may cause engine failure and is likely to reduce engine life and reliability: (1) What type is the starting device—direct crank, inertia-



Engine stand shown here exemplifies care and cleanliness essential during overhaul.

direct crank, standard inertia, cartridge, or other means? (2) When and how does the booster current cut in and out? Is it automatically engaged when the starter is meshed, or must it be applied manually? (3) What type of priming system is used? It might be three points to the carburetor adapter and diffuser section, five points to the cylinder intakes, or merely the acceleration pump in a float carburetor. Is the primer operated by a solenoid, or is it manual? Mistakes here can cause extreme engine damage by allowing the lower cylinders to liquid lock, or misuse can bring about severe backfiring and fire hazards.

Some of the other points are: Proper position and operation of mixture control, throttle, tank selector valves, propeller position control, supercharger control, fuel pressure switches, and fire extinguisher releases.

Generally, these various questions may be answered by consulting manufacturers' instructions, but the human element or technique also enters the picture.

Some mechanics could wear out a starter on a cold day and still not start the engine, others might accomplish the start on the first crank simply because of that intangible quality called technique. Of course, to start engines successfully requires experience, and this experience must be intelligently employed regarding such points as the use of the primer, length of run-up on the inertia starter, and the time for cutting in the magnetos.

Before starting, the mechanic has fixed in his mind the locations of the primary engine gages, namely: Oil pressure, tachometer, manifold pressure, engine temperature, oil temperature, and fuel pressure. Not only has he a clear picture of their location but he also knows what each reading should be during start and warm up. Any deviation from these preconceived pictures of the instrument panel, should instantly bring the action necessary to correct the improper reading.

Setting of cooling controls, such as flaps and oil cooler shutters, should be as much a part of the starting and warm-up procedure as operating the throttle and switch. Almost without exception the cowl flaps should be open for ground running in spite of low head temperatures. When the engine has been brought to a point where the oil pressure does not fluctuate with variations in throttle position, the mechanic taxies to the 100-octane fuel pit, allows the engine to cool, and then shuts it down so he can care for his original job of refueling. Before leaving the cockpit he makes a quick check for leaking primers and for exhaust fumes from leaking manifolds or heaters. He also notes that all switches, valves, and controls are in their proper position.

From the foregoing we may readily see that the competent line mechanic is more than a handler of oil cans and gasoline hose. Even the actual refilling entails grounding the airplane as a safeguard against fire from static, checking filler caps for type and quantity of fuel and oil, noting the conditions of breathers and vents, assuring absolute cleanliness of liquids, and inspecting fuel strainers for water and foreign materials.

In observing this competent line mechanic at work, we may note that instead of supplying the oil from a readily available pump cart of "X" brand, he walked some distance and returned with a supply of "Z" brand. This was because oil should be of the same brand as well as the same viscosity as that already in the engine, since various oils differ slightly in their chemical make-up after being refined. Although any oil of aviation grade is satisfactory when used alone, mixing different brands may spoil the good qualities of all by bringing about undesirable chemical reactions, causing

formation of sludge and engine varnish and resulting in clogged oil passages, poor lubrication, and improper heat conduction due to sludge coating of engine parts.

Our good mechanic's job is not completed until he is assured of the security of all filler caps, cowl plates, and gage sticks, and has wiped up any spilled fuel or oil. Finally, he notes the accomplished work in the record and signs for it.

Changing Plugs

Replacement of sparkplugs is one of the more common jobs handled by the line mechanic. A small wrench is provided in most engine tool kits for loosening and retightening sparkplug elbow connections. With this tool, the butchering that occurs when pliers are used will be avoided.

It is to be noted that over-tightening with a standard wrench will damage both harness and sparkplug. A deep socket wrench, a torque-indicating extension handle (or a short handle permitting reasonable torque judgment), and sparkplug thread lubricant are the main items needed for the plugs themselves. Plug racks and thread protectors are also handy; their use will be discussed later.

It is good practice to loosen both ends of the sparkplug elbow before removing the sleeve and terminal from the plug. The extra flexibility back of the elbow is a valuable aid in removing the terminal without cramping the sleeve in the plug barrel and possibly damaging both terminal and sleeve. If a terminal assembly is jerked out in a careless manner, or if the terminal spring is allowed to bear against the inside of the plug barrel, damage is likely to result and the mica interiors of some plugs may be scratched or chafed, impairing the insulating value and shortening the life of the plugs.

Other common troubles stem from bending the "pigtail" (or terminal contact spring) out of alignment, or cracking the terminal sleeve (or "cigarette"). Terminal assemblies damaged in the above ways are very likely to harm new plugs or flash over and cause as much trouble as did the original worn plugs.

When all the elbows and plugs have been loosened enough to turn easily with the fingers, each plug should be removed, placed in a rack, and a new plug substituted for it in the engine. New plugs may be left finger tight until ready to apply the final torque to all plugs.

Foregoing procedure serves two purposes. First, it prevents the entrance of dirt and other foreign matter into the cylinders. Equally important, it makes it easy to place the plugs in an orderly fashion in a rack. It takes a little more care to place plugs in a rack than to toss them loosely into a box, but a number of advantages are gained by the expenditure of the extra effort.

One advantage is purely mechanical. Racking of plugs prevents threaded portions from striking each other. Damaged plug threads stick in bronze cylinder bushings, and any mechanic who has experienced the dubious pleasure of removing a plug that has married itself to the cylinder bushing will concede the point that the ideal system is to provide plastic or brass thread protectors for each end of the plug.

Second advantage gained in numerical segregation of sparkplugs is the fact that the trouble shooter may then examine the electrodes to detect just which cylinders are fouling worst. This information helps solve the ignition troubles and is frequently of great value when investigating excessive oil consumption.

If each mechanic were to purchase, from his own pocket, a set of high grade aircraft sparkplugs, he would quickly gain a conception of their costliness. Aviation plugs are expensive because they are precisely made. They demand correspondingly precise service and installation.

Thread lubrication is a frequently overlooked point. The thread lubricants withstand the tremendous heat involved and should most certainly be used—but sparingly. A strip of lube should be laid up the side of the base thread with a small stick about the size of a match. Never "dunk" the plug nor allow the lubricant to work down around the electrodes. No lubricant is necessary at the elbow connection, in fact it is highly undesirable.

Sparkplugs should turn in easily with the fingers until they are almost ready to bottom against the washer. If a plug cannot be turned in without a wrench, inspection should be made to determine the cause of the binding. Damaged threads in the bushing or on the plug will usually be found.

When all plugs have been replaced "finger tight", the final tension should be applied with a torque-indicating extension handle on the proper size deep-socket wrench. Torque values as high as 450-500 in.-lb. have been used and probably are conducive to excellent heat conduction; however, experience shows that 400 is ample and even lower values—around 350 in.-lb.—are now coming into vogue to obviate the troubles so commonly encountered in removing plugs. Excessive tightening may cause plug sticking, thread damage, and sometimes electrode distortion.

If a torque wrench is not available, the mechanic must still apply the proper torque on each plug. One manufacturer recommends a wrench with a 10-in. extension handle. This should be satisfactory if the mechanic is careful to apply the pressure always at the same point on the wrench handle and if he has a reasonable sense of "feel".

Good practice calls for a gap-clearance check (which may be eliminated if the plugs have just been shop overhauled and adjusted). Gently remove any moisture or foreign material from the barrel of the plug with a cloth-covered stick of the proper size, or a pipe cleaner twice folded double. When using mica plugs, caution should be exercised to turn the cleaner in the same direction as the mica is rolled in order to prevent picking up of the mica. A clockwise direction is usually correct, although it's a good idea to check first.

Sparkplug terminal contacts and sleeves must be clean and free from any indications of burning, cracking, chipping, or oiliness. Where ignition conditions are critical, finger prints may cause flash-over, so never work on ignition parts with greasy hands. Use carbon-tetrachloride to remove grease or oil around the terminals.

Harness elbows and assemblies should be individually inspected for dirt, cracks in shielding and insulation, missing washers, missing or chafed grommets and moisture seals, corroded shielding, broken elbows, and crossed threads.

The small "tee"-shaped elbow nut wrench provided by the manufacturer is handy and in addition provides a reasonable gage of the proper torque. If such a wrench is not available, the mechanic should use careful judgment in tightening these nuts. Only enough torque to make a secure job is necessary; further tightening may cause the plug core to rotate or may distort the electrode.

We have now observed, in some detail, two jobs commonly encountered by the line mechanic. Other tasks might have been considered, however these serve to illustrate not only the mechanical techniques involved but also the proper attitude necessary.

The capable airplane engine mechanic exercises close observation of detail, follows systematic work sequences, has a specific purpose for each movement he makes, continuously applies himself mentally while working, has a healthy curiosity, and is ready to make honest admission of errors or doubts. These are his prime traits. Deviation from them, or overconfidence or carelessness, will sooner or later bring trouble.

Warehouse on Wings

If all his sources of supply were just across the street, a retailer could cut inventories to the bone, yet never miss a sale. Now, by specifying delivery via air, a merchant can in effect move those warehouses next door. Ordering just ahead of the market, he can ride the peak of a season, or a style, or a rush for a new product. His capital turnover is rapid; he needs less credit. Overstocking of highly expensive or seasonal items is avoided.

But the list of items which can move economically in the warehouse on wings is not long enough at present. The job now is to explore all fields of merchandising, to find more goods which can travel via air with benefit both to merchant and to air carrier.

Still another job is to bring rates down so additional goods can move economically via air. Such rates evolve from maximum efficiency of operation and also from full payloads. Wright Cyclone engines, with a payload bonus due to their lower weight ratio, and with ease of maintenance and low fuel consumption to provide efficiency, are helping to make such rates a reality.

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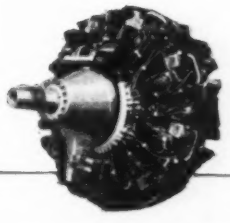

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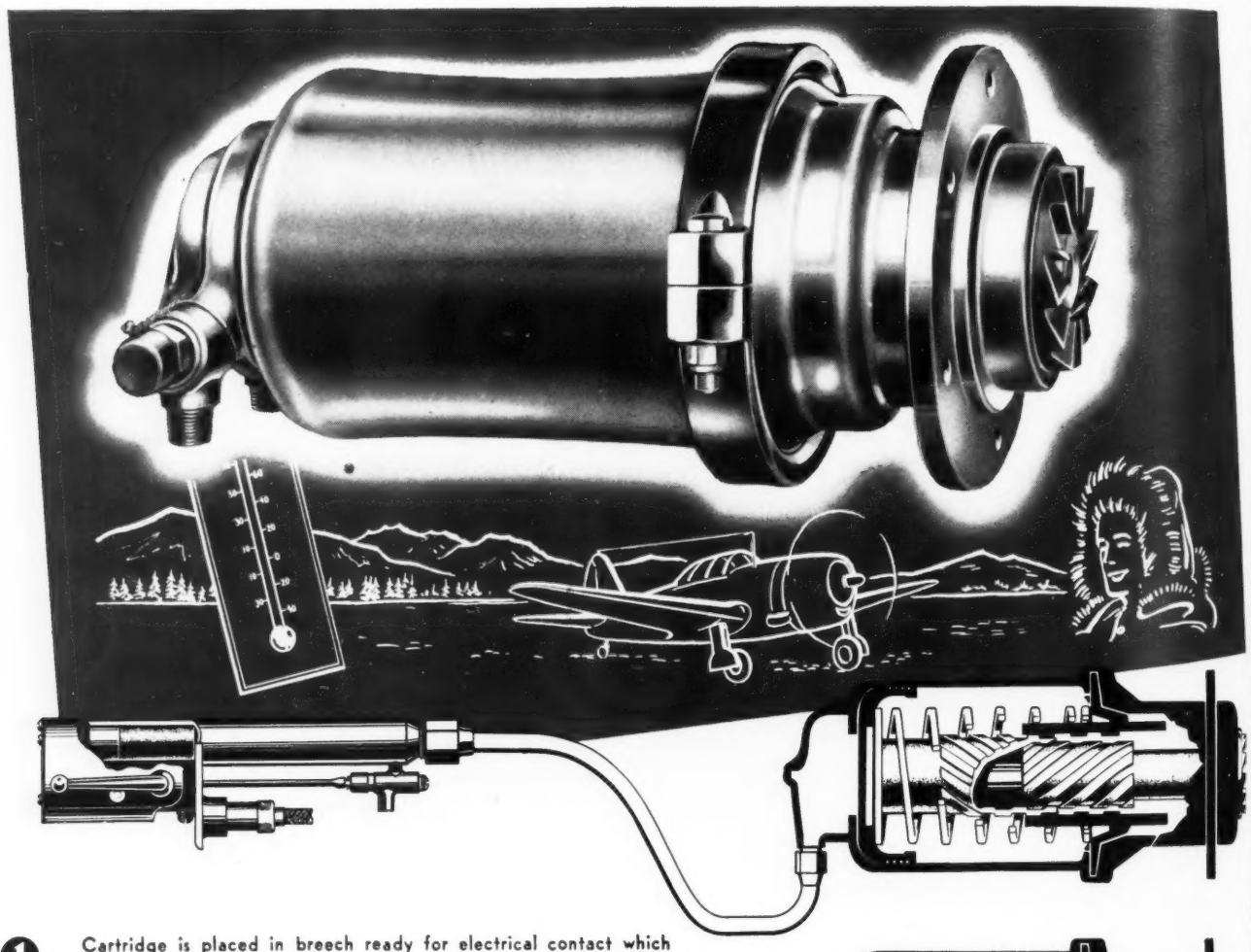

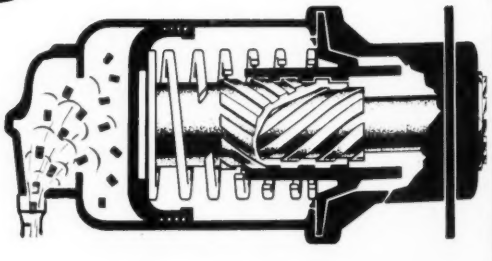

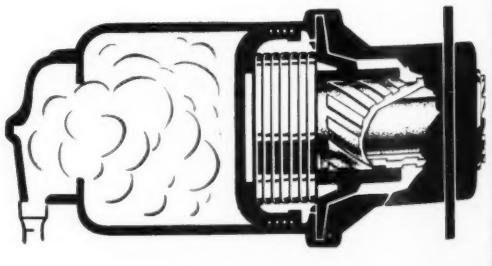

1. Cartridge is placed in breech ready for electrical contact which will ignite quick-burning powder and drive slow-burning pellets into combustion chamber.

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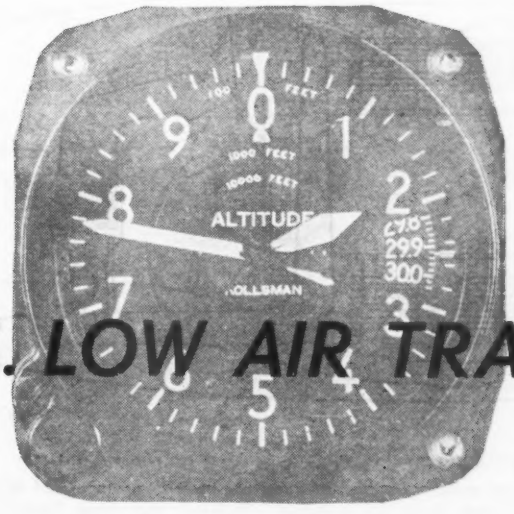


HIGH VS. LOW AIR TRANSPORT

PART II

By PHILIP COLMAN, *Chief Aerodynamic Engineer, Lockheed Aircraft Corp.*

Engine power requirements for high and low altitudes are here compared—to the manifest advantage of the high altitude design.

CRUISING POWER required at altitude dictates the lower engine brake horsepower necessary for a transport craft. This may be any percent of m.e.t.o. (maximum except takeoff) power up to 70 percent, and it is dependent on other transport design prerequisites.

It is beneficial to obtain as small an engine as possible, because a larger engine requires a larger nacelle, causing higher drag and greater empty weight. High bhp., particularly at takeoff, must be chosen as a safety requirement because that is its basic function.

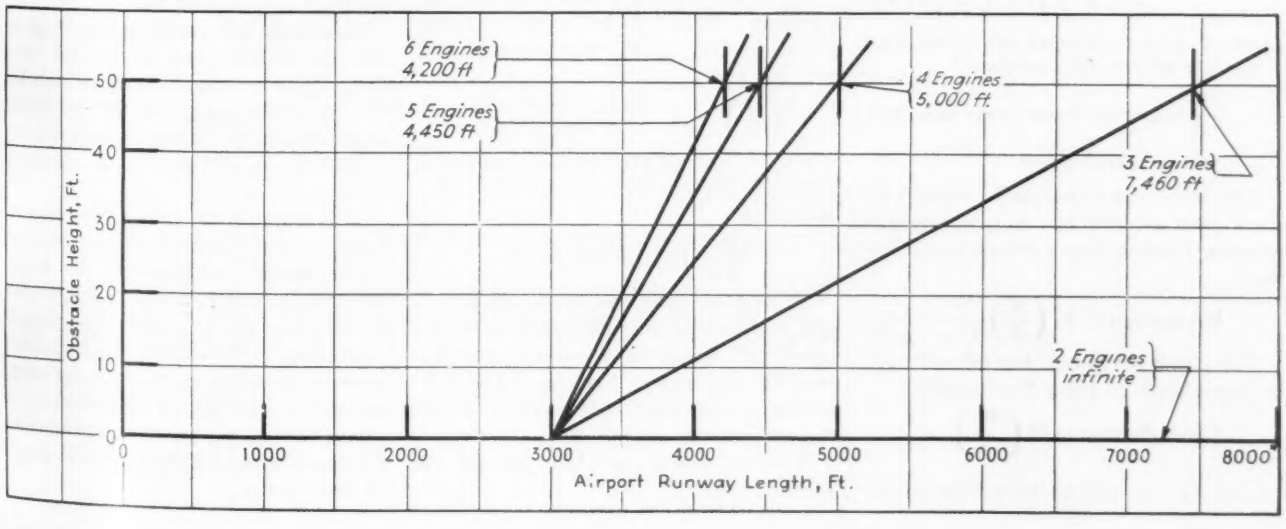
Today, we have a guide to define flight safety in terms of airplane performance, as presented by the Civil Aeronautics Authority in CAR 04.75. Under CAR 04.7531-T are specified certain rates of climb required for the airplane in landing, approach, and takeoff, while CAR 04.7532-T defines takeoff runway length in terms of the distance to accelerate from standing start to critical ground speed, plus the distance to climb to 50 ft. altitude with one engine inoperative.

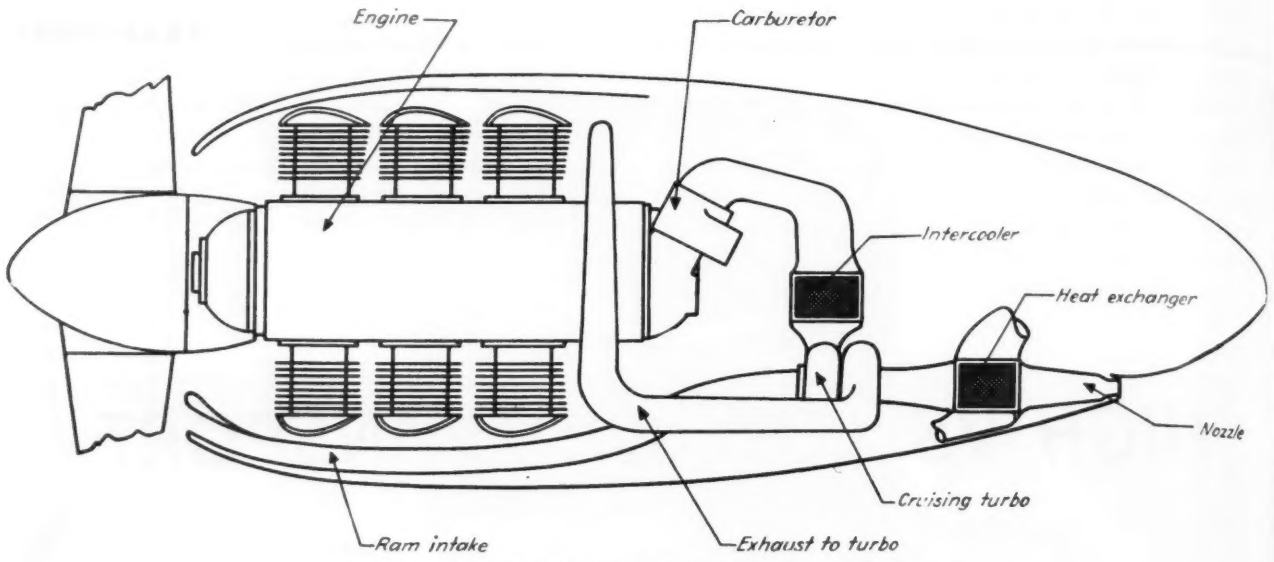
Because airports are of limited size, this latter requirement is the most critical relative to a large, long-range transport. Therefore this prerequisite may determine takeoff bhp. or the takeoff powerloading for the airplane.

For an example, a four-engine airplane is assumed. This choice may be briefly explained by the graph in Fig. 3. An airplane with a given total bhp. will take the same distance to accelerate to the critical speed with all engines operating, regardless of the number of engines employed. This assumes that the same critical speed for each engine installation, also sufficient lateral control, is available. After critical speed is reached, climb must be made with one engine inoperative, and the more engines, the less critical will be the loss of one of them.

Fig. 3 is based on the four-engine air-plane requiring a total distance of 5,000 ft. A three-engine airplane requires 2,450 ft. more; a five-engine airplane, 550 ft. less. While such a two-engine airplane does not get off the ground, a six-engine airplane reduces the distance another 300 ft. Thus, the

Fig. 3. Graph shows various runway lengths required for aircraft having constant bhp. but equipped with different numbers of engines.





Section of nacelle for high-altitude engine with arrangement of supercharger and ducts for greatest efficiency and least frontal area.

more engines the better, from the takeoff viewpoint. But the more engines the greater the weight and drag, plus another very important aspect—the greater complexity of design and control which might detract from the actual safety of flight.

The decision here is that if a well balanced four-engine design can be made affording a takeoff of 5,000 ft., the gain over the three-engine airplane is 50 percent, and the loss compared to a five-engine airplane is 10 percent in airport runway length.

Returning to the derivation of required takeoff power loading based on CAR 04.7532-T, the following equations apply:

$$\text{Ground run} = \frac{K\,(W)\,(V)^2}{Te}$$

where: K = constant, = takeoff weight
V = critical takeoff speed
Te = average excess thrust = thrust available minus friction minus drag.

This may be rewritten in the form:

$$\text{Ground run} = \frac{K\,W^2}{(C_L)\left(\frac{\rho}{2}\right)(S)\left(\frac{Te}{P}\right)(P_{TO})}$$

where: C_L is a constant take off lift coefficient
ρ is air density, a constant

$\frac{Te}{P}$ is average thrust-power ratio, and

P_{TO} is takeoff power

The following equation is written to show that ground run is proportional to wing loading times the power loading:

$$\text{Ground run} = K_1\left(\frac{W}{S}\right)\frac{W}{P_{TO}}$$

The climb portion of the takeoff may be approximated from the formula:

$$\text{Climb distance} = 50\left(\frac{W}{Te_1}\right)$$

where Te_1 = excess thrust in climb, the thrust less the drag. The drag cannot be neglected in this equation, because with one engine inoperative it approaches the value of the thrust. The equation may be rewritten:

$$\text{Climb distance} = 50\left[\frac{W}{\left(\frac{T}{P_2}\right)(P_{TO}) - \frac{DV}{375}}\right] = 50\left[\frac{W/P_{TO}}{\left(\frac{T}{P_2}\right) - \frac{(W/Pm)\frac{W^{1/2}}{S}}{37.5(L/D)\left(\frac{\rho}{2}C_L\right)}}\right]$$

This equation is given to prove that the total distance is a complex function of wing loading and power loading. However, to demonstrate the point in mind it is permissible to say that the total runway length required is a function of power loading times wing loading. Substituting back from calculations, an approximate formula for an airplane of the size and type considered herein for a 5,000 ft. airport length is:

$$\left(\frac{W}{S}\right)\left(\frac{W}{P_{TO}}\right) = 770$$

Consider now the power required for cruising flight. The equation for power loading based on cruising power is:

$$\left(\frac{W}{P}\right)_{cruise} = \frac{375\,(L/D)\,(n)\,(\sigma^{3/4})}{Vi}$$

where, following previous assumptions, L/D = 23, = .87, Vi = 180 mph. indicated.

$$\left(\frac{W}{P}\right)_{cruise} = 41.7 \times \sigma^{3/4}$$

With a cruising and a takeoff formula, a choice of desired power percentages will result in a choice of wing loading and power loading. The following percentages are derived from typical current engine data:

Takeoff power = 120 percent of m.e.t.o. power.

Cruise power for low specific fuel consumption at initial flight weight
= 65 percent of m.e.t.o. power
= 54.2 percent of takeoff power

Using the two formulas derived, the following takeoff power loadings and wing loads are obtained:

Altitude	$\sigma^{3/4}$	$\left(\frac{W}{P}\right)_{cruise}$	$\left(\frac{W}{P}\right)_{TO}$	$\left(\frac{W}{S}\right)_{TO}$
5,000 ft.	1.077	38.8	21.0	36.6
15,000 ft.	1.261	33.0	17.9	43.0
25,000 ft.	1.494	27.9	15.1	51.0

For the choice of a well-balanced design, wing loading must be related to the maximum lift coefficient available from the wing. For the maximum values, two more CAA regulations must be used. CAR 04.7530-T states that the stalling speed at landing weight shall not exceed 80 mph., while CAR 04.752-T specifies that the maximum takeoff weight shall not be greater than 1.15 times the landing weight. Using these regulations and the data from the previous tables:

Altitude	$\left(\frac{W}{S}\right)_{landing}$	C_L max.
5,000 ft.	31.8	1.94
15,000 ft.	37.4	2.28
25,000 ft.	44.3	2.70

Maximum lift coefficients as high as 3.0 can be obtained by careful wing design and prodigious use of high lift devices. The maximum lift coefficient required for a transport designed for 25,000-ft. operation is a calculable value.

This analysis has been shown to demonstrate that the high powers required by the dictates of the Civil Air Regulations, for safety, are not excessive for an airplane designed for high altitude operation. Relatively high takeoff powers are required, not only for safety but also for maximum utilization of the range of cruising powers, starting with the maximum economical cruise power of the engine.

FOR *Better Design*

DIVE FLAPS PERMIT CK AND SAFE PULLOUTS

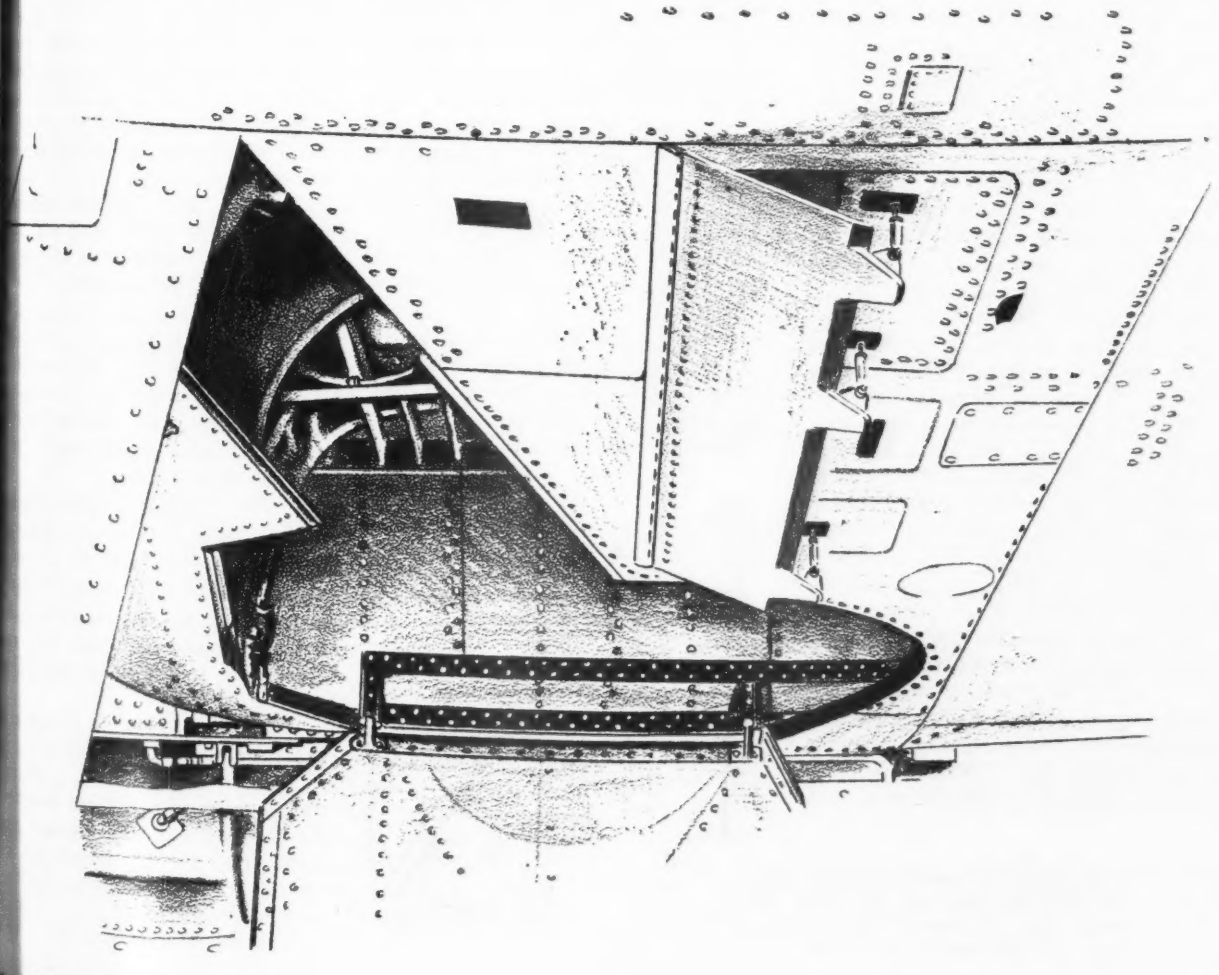
CE MODERN AIRPLANES have been taining very high speeds at alti- de, resultant compressibility ef- n performance have necessitated esign considerations.

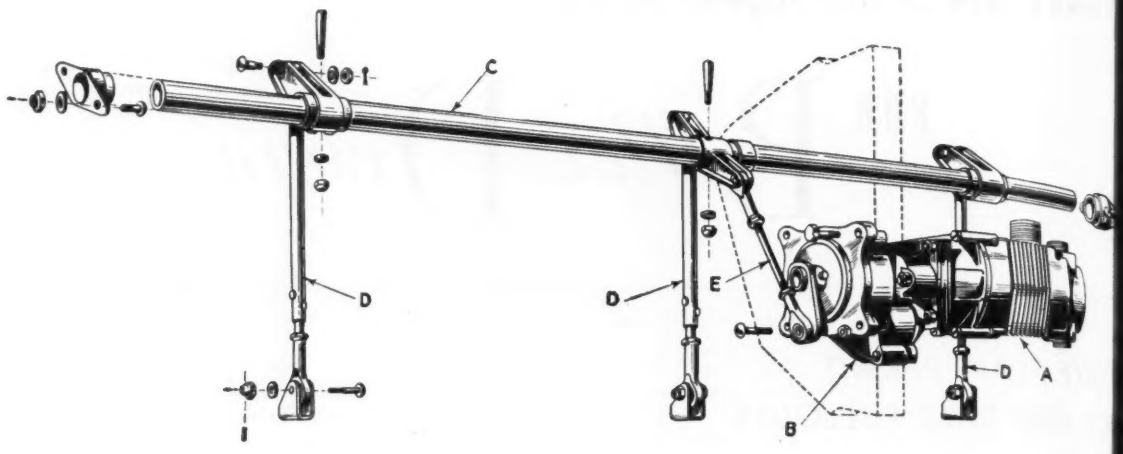
ortant changes in flight charac- s during a dive in which com- ility effects are encountered,) Increased diving moment re- from rearward movement of the center of pressure on the wing when shock occurs, and (2) rearward movement of center of pressure on the elevators.

By designing compressibility dive flaps for the fast P-47 Thunderbolt, Republic Aviation engineers have provided means to counteract these undesirable changes and afford safe pullouts at critical speed and high altitude.

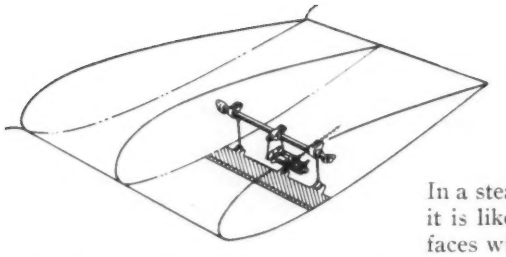
With the advent of heavy wing loading and good aerodynamic cleanliness, fighter planes have attained dive speeds approaching that of sound. It is to be expected that all airplanes will run into difficulty—that is, exhibit unusual flying characteristics—at such speeds. The ratio of airplane speed to sonic speed is known as the Mach number, and the same true airspeed corresponds to different Mach numbers at different altitudes since speed of sound decreases from 763 mph. at sea level to 666 mph. at approximately 35,000 ft., above

Shown here is P-47 Thunderbolt compressibility dive flap installation in extended position, with transfer (control) rods visible at rear. Flap is located at approximately 30 percent of airfoil chord, near wheel well. Flap span is 40 in., chord 6 in.





Exploded view of dive flap assembly showing: (A) Motor, (B) reduction gear housing, (C) torque tube, (D) transfer rods, and (E) actuator rod for torque tube, attached to reduction gear bell crank. Sketch at lower left shows relative position of installation in wing.



which this speed remains constant.

Air flowing over a curved body experiences an increase in speed over that of the undisturbed air. Thus it may happen that although the speed of the body is not that of sound, the speed at some local point on the surface has attained this speed. Accordingly, the steadiness of the air adjacent to the airfoil breaks down, and there develops what is known to the aerodynamicist as a compression shock. The airplane speed at which this occurs is different for various bodies or airfoils, and the ratio of this speed to sonic speed is known as the *critical* Mach number, and is of great importance in all compressibility effects.

With the establishment of this shock wave, the flow over the wing, body, or tail surface changes in such way as to cause rearward movement of resultant loading over the surface, an increase in drag of the surface or body, and a material change in the width and degree of turbulence of the wake.

Because of increased diving moment which results from rearward movement of the center of pressure on the wing when compressibility shock occurs, and the rearward movement of the center of pressure on the elevators, a greater force is required to pull out of a dive. In a steady dive at high Mach numbers, it is likely that the horizontal tail surfaces will be in the thicker wake of the wing and therefore be subjected to buffeting. For the ailerons or control surfaces in which there is any tendency of the balance portion to protrude into the free stream, the resulting change in loading over this portion may be such that rapid reversals of stick force occur.

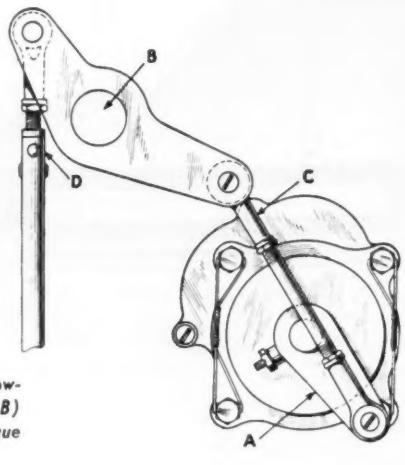
As a result of high speed and high wing loading, the following phenomena —which are direct effects of compressibility—have occurred in high-speed high-altitude dives with the P-47:

1. Rapid reversal of aileron stick forces when the controls are not neutralized.

2. Buffeting of the horizontal tail.

3. Freezing of the elevator control, exhibiting itself in the feeling as if the stick were set in concrete.

These are indications that compressibility is occurring over the wing ailerons, and that there is a position of the same existing at the tail.



Detailed view of dive flap linkage showing: (A) Reduction gear bell crank, (B) torque tube, (C) actuator rod for torque tube, and (D) transfer rod to flap.

It is important to note that ab is an extremely important fac pulling out of high speed dives. test records on the P-47 show whereas the pilot may run int culty at altitudes between 25,00 37,000 ft., in every instance know airplane is controllable at about ft. if the following diving tech are observed:

1. Since, as a tactical maneu steep dive in excess of 45 deg. a to have no value, this diving should never be exceeded.

2. The pilot should not enter th from a half-roll, because in this m ver he may not have his control tralized, and since he picks up at a greater rate than in any maneuver, aileron buffeting or "s may be experienced.

3. The airplane should be so tr at the speed at which the dive tered, that the force on the st either zero, or a slight push is req

4. No change in elevator trim the dive should be made. This r mendation is made for the foll reasons:

When an airplane is diving a Mach numbers and therefore sub to compressibility shock, a cha the elevator trim will not be eff As the airplane loses altitude a cedes from the compressibility the trim tabs become very effecti very short period of time—2 or

Had the pilot, during the co

ve and while the airplane was ted to compressibility shock, ed the plane more tail heavy in an ssful attempt to pull out, he be confronted by a dangerous tail condition when the craft reached altitude and compressibility shock eared. The pilot would then insufficient time to correct this trimmed condition, and the pullout be made at excessively high load s, probably resulting in structural ge to the plane and physical injury pilot.

Power should never suddenly be ed as this would appreciably e the stability of the plane and to put it into a steeper dive. How- it will be necessary for the pilot just his throttle gradually so as to ain, within reasonable limits, the condition with which he entered ive. This is necessary because tends to increase with an in- e in speed due to the increase in

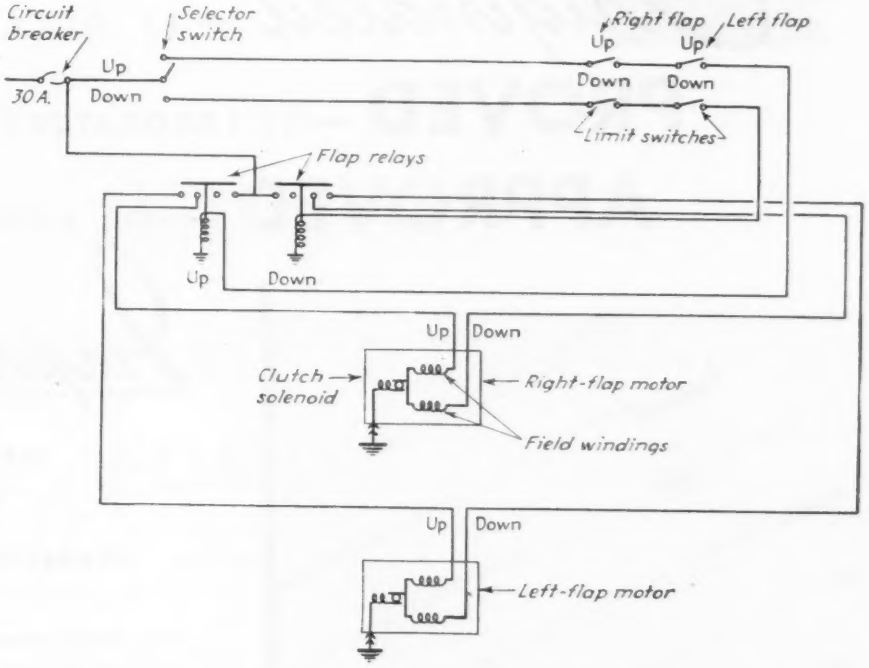
All pullouts should be made at an de above 10,000 ft., since the alti- lost in coming out of the dive is great on fast, heavily loaded s.

ough recovery may be safely at- d in dives at critical speeds if procedure previously described is wed, nevertheless inherent tactical dvantages result in the maneuver. example: When diving sharply on nemy plane which is flying at an de between 25,000-37,000 ft., the king pilot may pass the enemy e without inflicting damage and d want to resume an advantageous tion above it and as soon as possi-

ut if the dive were made at cal speeds, with recovery not pos- until 12,000 ft. were reached, able time and altitude would have lost if the pilot desired to resume attack.

lso, since altitude is lost so rapidly ng the dive, the human element rs, bringing with it uncertainty in proper correlation of controls re- ed for recovery.

These conditions are solved by the flap installation, which permits a rolled pullout at a critical Mach ber while still at a high altitude. increased diving moment which ld ordinarily result from rearward ement of the center of pressure on wing when compressibility shock rs in the dive, is more than offset the dive-flap action, which allows omatic recovery at a high altitude, ding G's to a safe limit in pullout.



Electrical circuit for dive flap actuation.

One dive flap is located under each P-47 wing just outboard of the wheel well. Constructed of .188-in. 24ST sheet, 40 by 6 in., each flap is hinged (at forward edge) to the wing, and is limited in travel to an angle of 21 ± 1 deg.

The flap installation consists of:

(1) The recovery flaps.

(2) Two reversible electric motors, with gear ratio of 245:1, one located in each wing. The motor gear shafts are connected to the recovery flaps by means of a system of levers, rods, and torque tube.

(3) A flexible cable, passing through the fuselage from wing to wing, connecting the two electric motors to assure flap synchronization. Couplings are provided in the cable between the wings and fuselage as quick disconnect units for wing removal.

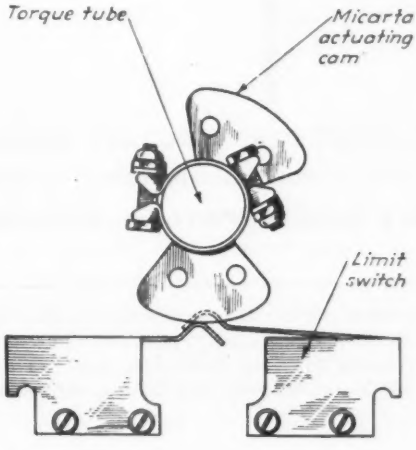
(4) Limit switches, actuated by Micarta cams clamped to the torque tube, to break the circuit when the flaps reach the full down or up positions.

(5) A relay located in the main switch and circuit protector box, electric switch located on the left side of the propeller selector switch panel, and circuit protector located on the main switch panel.

When the switch in the cockpit is moved to either *Up* or *Down*, as the case may be, current is sent through the *Up* or *Down* limit switches in the wings to the recovery flap relay in the switch panel box. This, in turn, sends a higher current to the actuating motors.

The magnetic brake and clutch in the motors are released electrically, and the motors operate to move the flaps up or down. When the flaps reach the full up or down position, limit switches are actuated, breaking the circuit to the relay, which in turn, breaks the circuit to the motor. As the current ceases to flow through the motor assembly, the brake is applied to prevent overtravel and slippage.

The cockpit switch has no *Off* position and must be left in either *Up* or *Down* position.



Limit-switch arrangement to break circuit when dive flaps reach full down or up positions.

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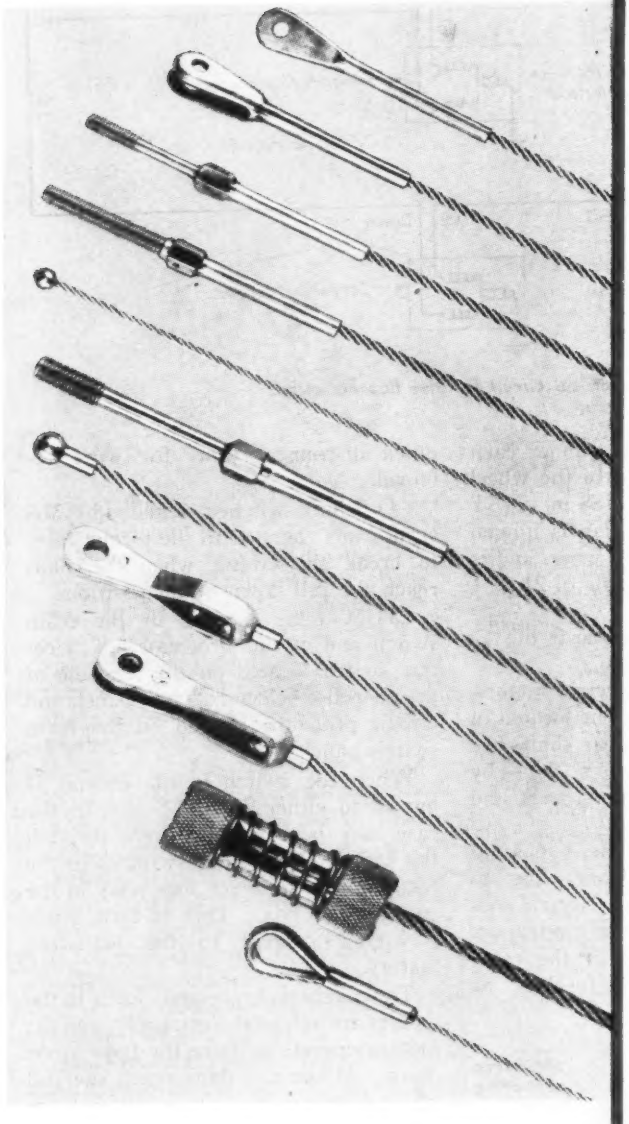

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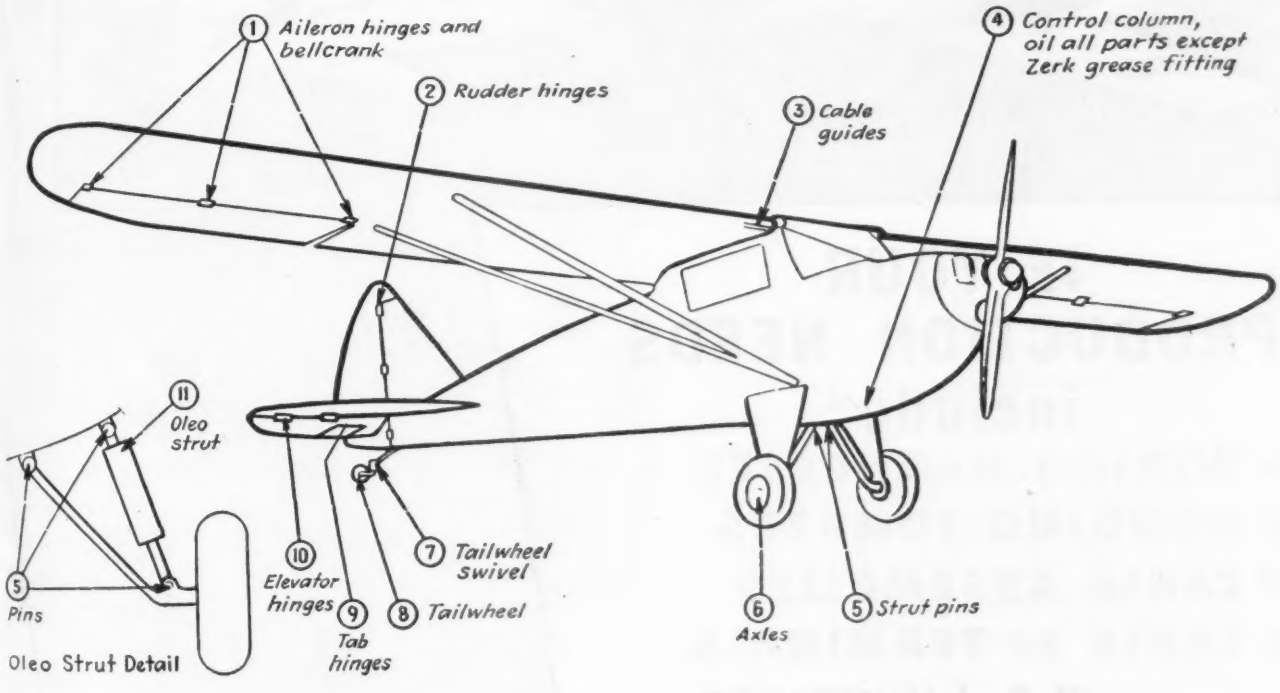


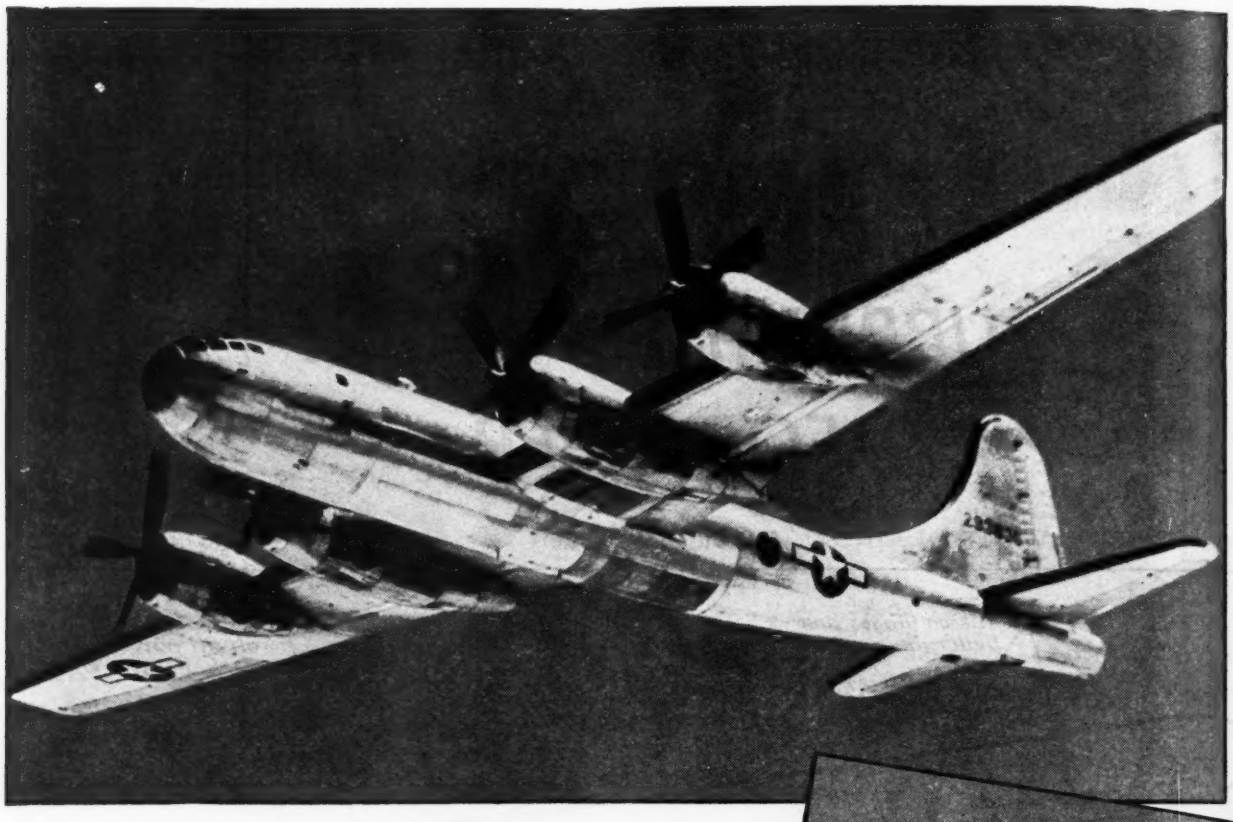
Engine. Uses SAE 40 (AN-VV-O-446A, grade 1080) in summer and SAE 30 (AN-VV-O-446A, grade 1065) in winter.

Grease. AN-G-3a, low-high temperature type is used at (8) *every 25 hr.*, at (4) *every 50 hr.*, and at (6) and (12) *every 100 hr.*

Engine oil is used *every 25 hr.* at (1), (2), (3), (4), (5), (7), (9), and (10).

Hydraulic fluid of type specified for cylinder (11) is added as required *every 100 hr.* Castor-base oil should be used if natural rubber seals are installed.

Whitaker Can Wire It



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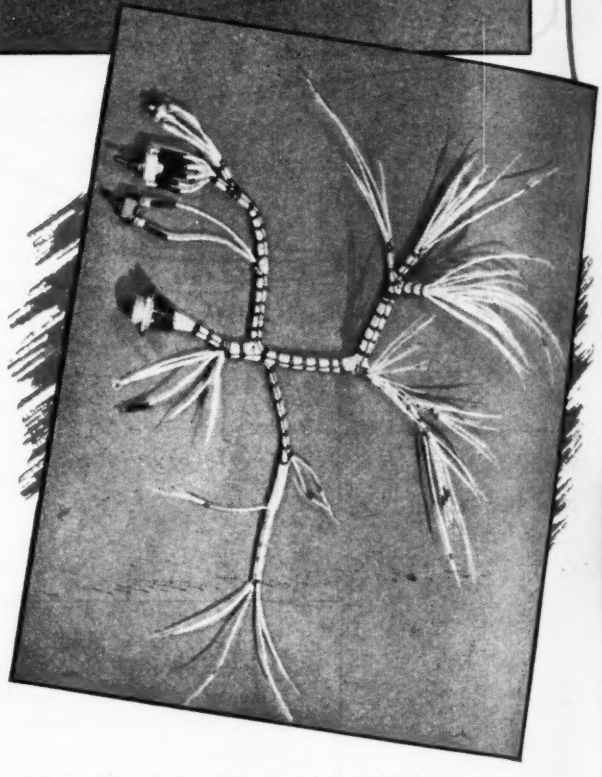

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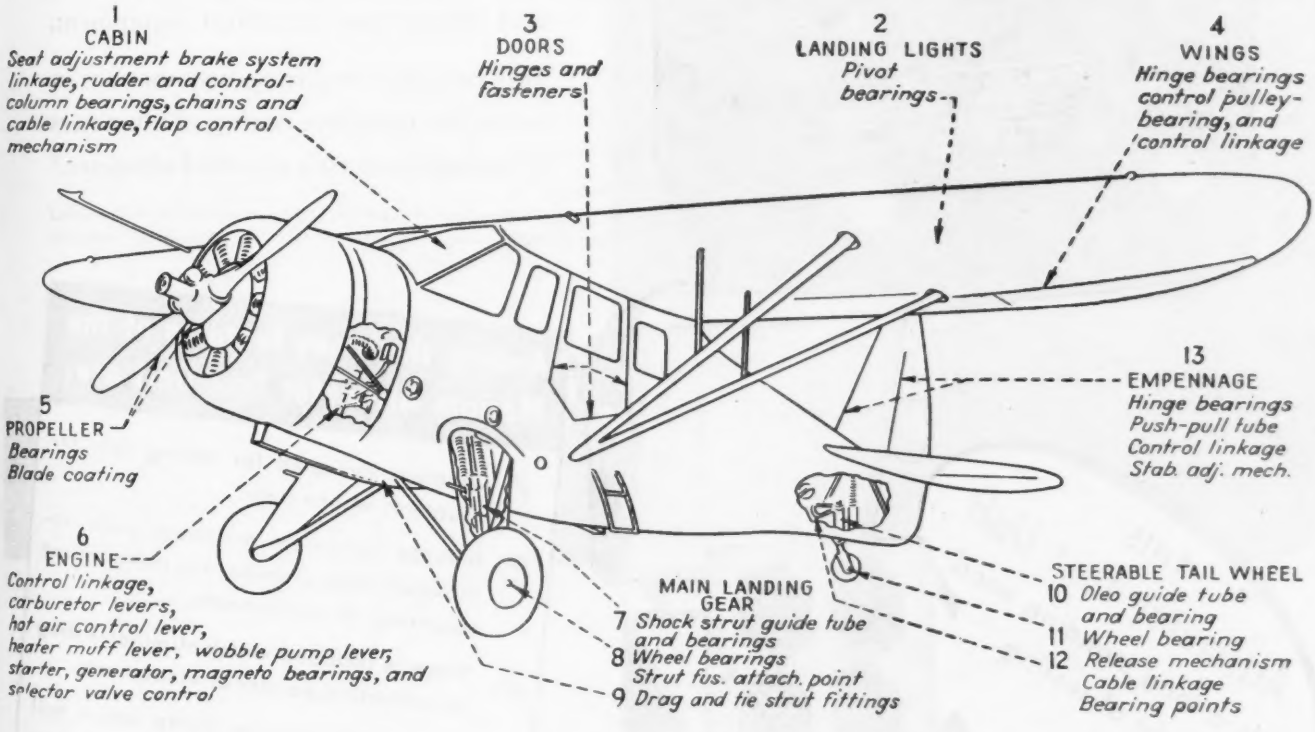
Models: DGA-8, DGA-9, DGA-11, DGA-12, DGA-15P, DAG-15P, DGA-15W; Navy Models: GH-1, GH-2, and NH-1



Engine. Uses SAE 40 (AN-VV-O-446A, grade 1080) in summer and SAE 30 (AN-VV-O-446A, grade 1065) in winter.

Grease AN-G-3 is used every *30 hr.* on points (1), (4), (9), (12) and (13) and also every *60 hr.* on (8) and (11).

Graphite grease AN-VV-G-671 is applied every *30 hr.* at (7) and (10).

Oiling. Same grades as for engine are used every *30 hr.* at (2), (3), (5), and (6).

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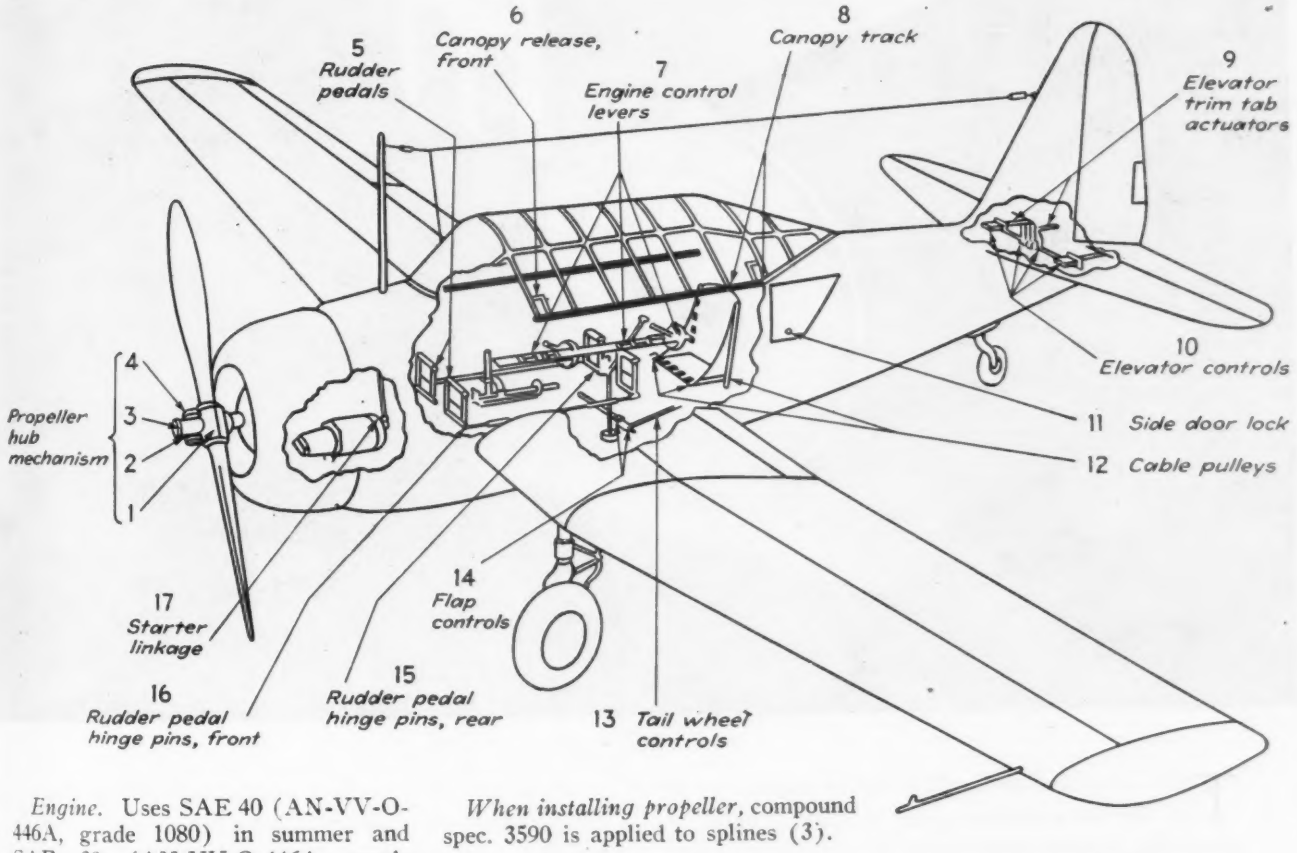


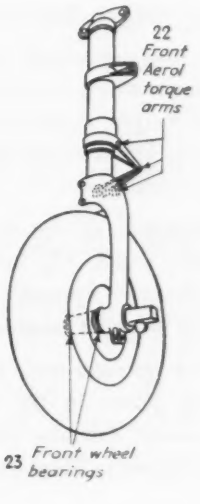
Engine. Uses SAE 40 (AN-VV-O-446A, grade 1080) in summer and SAE 30 (AN-VV-O-446A, grade 1065) in winter.

Grease. VV-G-671, hard, in summer and 3572, medium, in winter, are used at (15), (17), (18), (19), (20), (21), and (22) *every 25 hr.;* at (5), (12), and (16) *every 50 hr.,* at (9) and (13) *every 100 hr.;* and at (7), (10), and (14) *every 300 hr.*

Oil, spec. 2–27 is used at (6), (8) and (11) *every 25 hr.,* and oil spec. 2–91 is used at (2) *every 25 hr.*

Grease, spec. 3581, Mobile No. 2, summer, and spec. 3581, Mobile No. 1, winter, is applied at (1) *every 50 hr.,* at (23) *every 100 hr.,* and at (21) *every 200 hr.* Furthermore, Grease, spec. 3560-C, grade 210 is applied at (4) *every 25 hr.*

When installing propeller, compound spec. 3590 is applied to splines (3).



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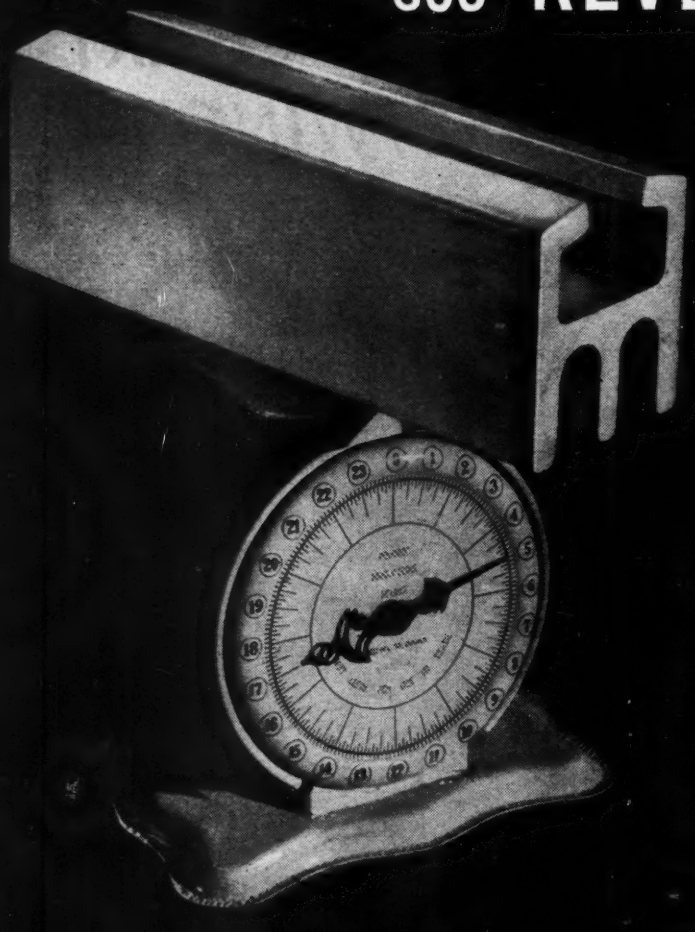

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The part shown here is used in an essential war application in which it meets four vital necessities—strength, light weight, corrosion resistance, and complete safety against fire even though exposed to seemingly hazardous conditions.

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...e heaviest Allied air at... on Germany so far, and ...most extensive use of tac... aviation, came together ...e 7,000-plane assault that ...ed to stop the great Ger... counter attacks in Bel... and France and went on ...ourge the enemy as the ... forces smashed westward ...heir great drive toward ...in.

...exibility of all types of ...at aircraft for hitting ... distant and local enemy ...ly sources and communi...ns, and also coordinated ...rheading in advance of ...s, proved most valuable. ...pan's sustained produc... of warplanes, with im...ed effectiveness, plus con...ration of air forces near ...e, have caused the United ...s Navy to abandon its ...aft cutback policy and to ... the industry it may ... increased production of ...ers, land-based craft, and ...g boats this year.

...ied air attacks on Japan ...er will greatly speed-up ... bases are taken close ...gh for use of B-17's, ...s, and medium bombers ...fighters. With such bases ...protection, the Navy can ... its ship-based aviation ...ore frequently for attack ...ose range.

...ndwork is being laid for ... expansion of civil flight, ...T. P. Wright, administrator ...AA, in a year-end state... CAA's airport program is ...irst requisite for postwar ..., in his opinion. He called ...mplification of flight regu...s; for $20,000,000 modern...n of CAA radio aids for ...ased traffic in all weather; ...ight training involving fed...id to colleges; and for CAA ...eration with manufacturers ...evelopment of aircraft of ...er popular appeal. Mr. ..., summing up accom...ments of CAA in 1944, said ...technical documents pre... for Chicago's Interna... Civil Aviation Confer... had been highly praised.

... plane manufacturers ob... to proposed aircraft develo... program in CAA, believ... would cause prospective purchasers to wait for newer designs. However, T. P. Wright, Administrator, responsible under law for development in public interest, is being firm in his objective. Probably CAA, manufacturers, and Aero Chamber will reach a satisfactory compromise.

Hearings were to begin Feb. 12 reviewing entire non-scheduled air operations picture. CAB under law has authority to certificate non-scheduled interstate services, but it has waited till regulation is needed. Some pending applications, long held in abeyance, may be acted upon soon. Non-scheduled competition with regular airlines is bound to become a problem. CAB Chairman Pogue, has recommended expansion of non-scheduled operations rather than establishment of too many so-called feeder lines.

Budget Bureau rejected CAA's request for funds to activate dormant Civil Pilot Training Program. Next move will be introduction of a bill in Congress, calling for the money. CAA favors training in schools and colleges with federal aid. CPT law of tenure expires during this session, and action will be taken on proposal to renew it.

Emergency flight rules, Sec. 60.95 of CAR, have been amended by CAB to reduce wartime restrictions on civilian flying, so that planes are no longer limited to designated landing fields. But each flight still must be approved in east and west defense areas.

A provision for construction of flight strips by Public Roads Administration has now been stricken from Federal Highway Aid Bill as a result of protests by CAA, Rep. Jennings Randolph, and Rep. Clarence Lea.

Six more of 64 Army contract flight training schools have closed, leaving 13 which may be retained in service until further decisive enemy defeats. Those schools released and in transition to civilian operations are standing by for further training of AAF cadets if necessary, according to Aeronautical Training Society.

National Aeronautic Assn. has become U. S. Wing of Inter-American Escadrille, a civil aviation organization in all American republics.

Formation is announced of The Air Force League, educational, non-partisan, and national in scope, to promote the maintenance of national security and further the cause of world peace through air power. President is Charles E. Wilson, and among directors are Lawrence D. Bell, Ralph S. Damon, Donald W. Douglas, T. P. Wright, Edward V. Rickenbacker, and Charles S. "Casey" Jones. Headquarters of group, which has been endorsed by Gen. Arnold and other AAF leaders, is 1203 Empire State Bldg., New York (1), N. Y.

Broader protection at lower rates for aircraft pilots is announced by Aero Insurance Underwriters. A $5,000 policy with $25 weekly indemnity for life is now available to pilots for $47, states AIU, whereas formerly this coverage ran to $82.50. A complete new aviation personal accident program is being offered for students, air crews, and passengers.

Wright Field reveals use of C-109's — Convair Liberator bombers converted into flying tankers—for flying great loads of gasoline over the Hump into China.

To assist CAA in planning increased postwar personal flying, an Advisory Committee on Non-Scheduled Flying has been created. Seven members of twelve-man committee will be from private airmen field, with selections from leaders in each of seven CAA regions. Remaining five will represent manufacturers, airlines, aviation consumers, fixed base operators, and state aviation officials.

Among considerations of recent SAE meeting in Detroit were: Army tests of heated wings as anti-icing equipment, design of aircraft control cabins, adequacy of world airports for use of giant planes, detonation control to save fuel and increase aircraft engine power, the aero-economics of flying buses and taxicabs, combined engines and turbines for the globe-girdling planes, and financing of aircraft for local air transport.

Bell-Marietta's conquest of production difficulties was highlighted at year-end when the Georgia plant nosed ahead of schedule in output of Boeing B-29's. Despite working out of "already-scraped manpower barrel," first anniversary of established production found personnel totaling 25,000, most trained from scratch. At recent Marietta press conference (Bell-ATSC sponsored and conducted by E. R. Hawkins, division p.r. mgr.) Maj. Gen. K. B. Wolfe, chief of engineering and procurement, ATSC, called on plant for tripled output. Here, B-29's come combat-ready from line, all modifications being incorporated in course of production.

HOW TRUCKS BOARD RECORD-BREAKING TRANSPORT

Via special ramp which folds into body behind pressure-tight doors, Army truck backs into Boeing's huge C-97 double-deck troop-and-cargo transport. First striking flight record of 1945 was logged Jan. 10 when this plane bluestreaked at 30,000 ft. from Seattle to Washington, D. C., to set new transcontinental mark of 6 hr. 3 min. 50 sec. Non-stop performance of pressurized craft bettered coast-to-coast time of 6 hr. 57 min. 51 sec. made last April by Lockheed Constellation, also surpassed record 6 hr. 39 min. time established by North American Mustang fighter last May. A military prototype of Stratocruiser airliner which Boeing plans for post-war, C-97 has same wing, tail surfaces, landing gear, and engines as B-29 Superfortress, however 12-ft.-longer fuselage is more than twice as commodious giving fully 10,000 cu. ft. of space. (Also see full views of plane on page 119 and 120.)

AVIATION MANUFACTURING

Even though some military authorities predicted that Germany's powerful effort to hold her borders could not last long, United States military command has put aside all thought of aircraft production curtailment. WPB Chairman J. A. Krug stated that even if Germans quit directly it won't make much difference in airplane program. He said that "significant" in-

creases have been made in Superfortress schedule, also that greater output of fighters and some other Army airplanes must be achieved.

Adm. D. C. Ramsey, chief of Navy Bureau of Aeronautics, announced that a 30 to 40 percent increase in fighter planes may be called for during 1945. At present, he said, aircraft program as a whole is behind schedule, but vital ship-based planes are coming through in sufficient quantity to meet present requirements. Attention is being given to long-range land-based planes for Navy, and more flying boats will be wanted, because battle for land space from which to operate will be difficult. New Jap tactics, plus enemy concentration as he backs toward his homeland, calls for more American air power, admiral said.

Military airplane program for 1945 has been stepped up 2,617 units to a total of 78,227. Unit production in 1944 was 96,369 as compared with 85,946 in 1943. Total airframe weight in 1944 was 1,112,000,000 lb., against 743,000,000 lb. in '43. Due to constantly increasing weight per unit, 1945 schedule is a bigger job than it looks to be.

December production was given as 6,697 planes, with weight of output, including spares, totaled at slightly over 71,000,000 lb., same as November. Unit figure in December was drop of 50 from 6,747 craft made in previous month.

Aviation industry dollar production value has been estimated at between $19,000,000,000 and $20,000,000,000 in year '44, as compared with a calculated $14,900,000,000 in '43.

Entry of Allison into the jet-power field emphasizes importance of this new type of airplane engine. Allison is first aircraft engine builder to move into jet-turbine production. At least four manufacturers are now engaged in jet-turbine production, and others in experimental stage may go to work on quantity orders at any time.

ATSC, engineering and maintenance component of AAF, announces it is increasing its effort to clear termination inventories from plants of AAF war contractors. ATSC recognizes its obligation to remove all items not sold or retained by contractor within 60 days after receipt of an acceptable inventory statement. Col. E. W. Rawlings is chief of ATSC's Readjustment Div.

Great bulk of surplus military airplanes eventually will end up on scrap pile. Of about 18,000 declared surplus so far, not more than 2,500 are considered suitable for any sort of civilian use. About 6,300 government-used planes have been sold, but 5,400 of them were civilian planes bought by Defense Plant Corp. for lease to CAA's War Training Service. In general, only light liaison planes and transports will be suitable for sale to civilians. Navy surplus will soon bring total to 25,000.

Wright Field's new 80-ft. high concrete vertical wind tunnel is testing airplane spin characteristics, terminal velocities, parachute performance, and helicopter rotor blades. An upward airstream is drawn through the 12-ft. cylinder by a wooden 16-ft. airscrew driven by a 1,100 hp. electric motor.

A group of American aircraft technicians recently traveled in England trying to bring about greater uniformity in standard parts, materials, and practices of the two countries. They have issued a report declaring British have carried standardization farther than has United States, and that cooperation is bringing benefits to both.

MUFTI-VERSION LANCASTER

Smooth-up job on Avro Lancaster's nose and tail, plus internal modifications, produced this "Lancastrian," civil version of famed bomber. Plane mounts two-stage-supercharged 1,250-hp. Packard-built Rolls Royce Merlin 38 engines, reportedly giving 215 mph. speed at 10,000 ft. with about 50 percent of takeoff power. Gross weight is put at 65,000 lb., tankage 3,200 gal., still-air cruising range 4,000 mi., passenger capacity 10, and payload about 4 tons. A small fleet of the new craft is in operation. (British Combine photo)

Curtiss - Wright's Louisville plant is tapering off assembly of C-46 parts, made by C-W in St. Louis, and is now increasingly modifying B-29's. When C-46 contract is completed in middle of this year, Louisville will devote entire capacity to the B-29 modification job. Any excess production of C-46 parts at St. Louis will be shipped to C-W Buffalo. North American has joined Fairchild in production of latter's C-82 Packets.

Proposals to terminate the Aircraft War Production Councils, organized early in war to streamline cooperation between airplane manufacturers, have been dropped for the present due to continuing need for maximum airplane output as a result of enemy strength and endurance.

Gen. H. H. Arnold, AAF chief, when questioned about prospective new bombers, B-35, B-36, and B-42, said he didn't want to talk about them. He would let enemy find out about them hard way, he said.

It is revealed that one of modifications on Boeing B-29's handled by Continental Air Lines Denver Modification Center is conversion of standard Superfortresses into special photo reconnaissance planes.

AWPC West reports '44 production by plants in its territory totaled 25,189, more than one-fourth nation's output.

Chevrolet has recently been awarded contract by Wright Field procurement hq. for over 9,500 P & W R-2800 engines, with estimated value of order totaling about $194,000,000.

Doak Aircraft Co. has received contract valued at nearly $5,000,000 from Ryan Aeronautical Co. for fuselage sections and control surfaces for Navy fighters.

Special punch-card rationing system for employees' purchase of cigarets has been introduced by Northrup company, based on allotment figured from previous sales. Workers now need not lose time from jobs or lunch or rest periods standing in line for smokes.

Chance Vought has stepped up production schedule with return to 53-hr. week from former 48-hr. schedule in effect last six months.

Lockheed calculates increased operating efficiency and new manufacturing techniques cut its production man-hours by 38 percent during '44.

At year-end, Consolidated Vultee production of military and naval aircraft totaled 30,159 planes and equivalent parts in period since Pearl Harbor. Fourteen different types of planes were being made by company during '44 in its eleven manufacturing divisions. Total of 9,387 craft turned out last year included 5,120 heavy bombers and transports, 4,074 of which were Liberator bombers . . . Convair's Fort Worth division is now rushing huge B-32 Dominators, last B-24 having rolled off line . . . Enough man-hours were saved last year by Convair employee suggestions to send equivalent of 2,000 Navy Liberators out to Pacific, officials state.

New record has been established in North American Aviation contract termination proceedings where settlement was made in less than 60 days. Contract, concerned with B-25 Mitchells at Inglewood plant, where last of 3,208 bombers left production line on July 7, '44, brought negotiated settlement of $1,890,783 as result of agreement approved by Army on Oct. 27, based on claim submitted by company on Sept. 4. Value of raw materials recovered during negotiation amounted to $1,164,576 with 95 percent of remaining inventory cost expected to be recovered. Parts and raw materials under the contract were diverted to other plants.

Auction was scheduled just prior to year-end to dispose of $1,000,000 worth of tools and surplus stock at Jacobs Aircraft Engine Co.'s Pottstown, Pa. plant, in preparation for new Navy contract following substantial completion of aircraft engine contract for Army. In another auction, Brewster Aeronautical Corp. was offering at Long Island City, N. Y., $2,000,000 worth of parts, machinery, and tools.

New boost by Navy in monthly production schedule of UAC's P & W Aircraft Corp. of Missouri plant brings additional output of 430,000 hp. as goal over 250,000 hp. increase assigned recently, making to monthly increase of 680,000 over original schedule to be tained by Nov. '45.

TRANSPORT AVIATION

In addition to requisitioned 3 airplanes returned by Army the airlines, Surplus War Property Administration recently located to operators a total 86 surplus military transports, mostly Douglas C-53s and s Lockheed C-60A's. Few airl have sufficient shop facilities convert these craft, hence seeking assistance of aircr and subassembly manufactur Due to capacity war product Douglas cannot accept con sion work.

United Air Lines sharply cr cized the Civil Aeronau Board recently in a petition reconsideration of the boa decision granting the Den Los Angeles route to West Air Lines, for which Un also had applied. United ch acterized decision as "a tr mistake," contrary to public terest, made as a result board's desire "to protect We ern Air Lines against diver of revenue." It continued: " board has become so in upon aiding small carriers— incidentally making richer men who now control the that it is slighting its prim and all important duty, whic to develop air transporta and make it as effective as sible for the traveling pub

Plans were formulated at a cent Washington meeting f world air transport associat whose policies would be dire by operator members th selves, without government filiations. United States, Brit France, Sweden, Mexico, C and Poland were represen The committee drafting by- indicated a desire for close operation with the new In national Civil Aviation Orga zation.

Announcement by UAL that fares would be reduced 60 from the year-end is expe to bring reductions by transcontinental routes. Pre average of United, Ameri Eastern, and TWA is about per mile. Several other have, of course, promised d tic postwar cuts. Railway press Agency announced sixth tariff revision, with reductions.

Army ATC and Naval ATS started carrying civilian passengers who cannot be commodated by regular airli State Department handles orities on these non-mili travelers, who must show reason for trips.

A Congressional resolution CAB 90 days extension. Jan. 1, to present recommen tions on multiple taxation of lines. Supreme Court last recommended, as a result decision against Northwest lines, that an equitable law enacted.

New information bureau been set up in Washing D. C., by Air Transport A comprising 21 airlines. Add is 1515 Massachusetts NW, Washington (5), D. C. phone number is Execu 2929. Perley Boone is dire of press.

Some observers see probabl of increased airline interch of equipment and more gers. CAB recently certifie Northwest Airlines for Min kee to New York, and Pe Central from Pittsburgh to

More and More
HELLCATS
PRODUCTION SCHEDULE
F6F MODELS
PRODUCTION SCORE CARD 10 FEET HIGH
Here, month after month, Grumman records their amazing production of Hellcats, every new figure boding more bad news for the Japs.
ON STRONGER, SAFER TIRES

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"Give us planes with more speed, more climb...something that will go upstairs *fast.* And we need them *quick.*" That's what Navy pilots called for in the dark days that followed Pearl Harbor when the air over Pacific Islands was full of slithering Jap Zeros.

Grumman Corporation answered that call ...quickly...with Hellcats, one of the fastest fighters in the sky.

The first handmade experimental model flew in July, 1942. By the end of 1943 Hellcats were battle-famous. Today, thanks to the amazing Grumman production record, thousands of Hellcats roam the Pacific, their altitude, maneuverability, speed, range and climb enabling our Navy fighters to pile up ratios of 5 to 1 and 10 to 1 against the Japs.

OFFICIAL U.S. NAVY PHO

THE SHOCK IS BRUTAL when a heavy Hellcat smacks the carrier deck. But U. S. Royal Airplane tires are engineered for that kind of service. Their extra strong rayon cord construction provides the reserve strength that absorbs those shocks, their sharp edged tread blocks give the sure traction that holds the plane under control, brings it to a safe stop.

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DY FOR DUTY. Hellcats receive the final OK of vy Inspectors... are promptly flown to Navy bases begin their spectacular military career.

OFFICIAL U.S. NAVY PHOTO

WINGS FOLD BACK AS NEATLY AS A BIRD, making it possible to pack more Hellcats on the carrier deck, pack more punches when the battle starts.

OFFICIAL U.S. NAVY PHOTO

LCATS AT THE READY for deadly blows at Jap planes, ps, island bases. The Hellcat was the first American ne built out of combat experience in World War II.

OFFICIAL U.S. NAVY PHOTO

START OF A STRIKE—this Hellcat gets the take-off flag. A belly tank provides extra fuel . . . but adds weight. Another reason why tires must be strong yet light.

OFFICIAL U.S. NAVY PHOTO

ING UPSTAIRS FAST. The Hellcat flies in the 400-mile--hour class, fights at 35,000 feet and above and has a nge of 1500 miles or more.

OFFICIAL U.S. NAVY PHOTO

WHEELS DOWN, BRAKES ON, HOOK OUT—this Hellcat returns to its "nest". As it "hits the deck" tires must have plenty of reserve strength to take the shock.

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OFFICIAL U. S. NAVY PHOTO

BATTLE-FAMOUS HELLCATS LAND ON STRONGER, SAFER TIRES

As fighters go, the Hellcat is a big plane. Its wide-tread rugged landing gear asks favors of no landing field . . . is equally at home on the decks of aircraft carriers or improvised front line airstrips.

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...k. Members Pogue and War-... in dissenting opinions, ...lled attention to advantages ...t might have resulted from ...merger of the lines, and from ...tension of service by flying ...uipment of one line over that ... other.

...porting on 1944, ATA states ...ximum of 320 planes were in ...line operation as compared ...th 258 in '41, that express ...ried 82,133,104 lb. against ...,398,643, and that airmail lb.-... summed to 85,803,000,000 as ...ainst 26,236,027,723 in the ...r '41. Estimate of passengers ...ried in '44 is 3,658,140, an ...' from the '43 total of 3,-...,040. Priority passage was ...t at 54 percent as compared ...h 61 percent in '43. Last ...r's passenger load factor is ...red at 92 percent, compar-... with 82.28 in '43. This per-...t in 1935 was gaged at but ...61.

...my's ATC, reporting on '44, ...rs 1,250,000 persons were car-...d on its world airlines during ...e year.

...AA, returning its trans-Atlan-... fleet to commercial opera-...ns following completion of its ...ATS contracts, states its ...ns-Atlantic service in last ... yr. flew 6,700,000 plane-...les and carried 68,000 passen-...rs and 9,820,000 lb. of mail ...d express. A total of 305 trips ...ross the Atlantic were re-...rded by company in '44.

...rmation of a Western Div. of ...aniff's traffic department, ...th headquarters at Denver, ...announced. New division, un-... J. Kernan Weckbaugh, will ...clude Denver, Pueblo, Colorado ...rings, Amarillo, Wichita Falls, ...d Lubbock.

...rthwest Airlines' plant main-...nance and plant engineering ...ctions have been consolidated ... part of company's plan to ex-...nd commercial activities. New ...n will be known as plant ...d equipment section. Chief is ... J. McKellar.

...AL completed its Alaskan op-...ations for Army ATC just ...or to close of year. Record of ...mpany was more than 5,200,-...0 mi. flown, nearly 20,000,000,-...0 lb.-mi. flown, 33,500 military ...assengers carried, plus almost ...00,000 lb. of military cargo ...d more than 2,500,000 lb. of ...ail.

AVIATION ABROAD

Commonwealth Aircraft Corp. is to start production on P-51 Mustangs for Australia under North American Aviation license, receiving complete sets of component parts, subassemblies, and accessories for initial quota of fighters, after which Commonwealth will produce its own parts.

Interest of France in postwar civil aviation has been spurred by aeronautical research activities which continued underground during Nazi occupation, recently coming up with designs which include twin-engine passenger plane for European traffic; medium-range, fast twin-engine passenger plane; fast four-engine transport with accommodations for heavy cargo for use on Continental and trans-Atlantic runs; and high-altitude landplane, embodying improvements, for non-stop trans-Atlantic crossing.

First Argentine plant to be exclusively engaged in aircraft production was recently inaugurated at Quilmas, near Buenos Aires, under operation of Industria Metalurgica y Plastica Argentina. It is noted that, according to news reports, IMPA was placed on American blacklist in Oct. '44.

Brazil, under recent command assumption, has received 15 Consolidated Vultee PBY Catalinas from U. S. for air patrol of Brazilian coast and area extending over high seas to African point.

France has emphasized war production of aircraft by increasing plant employment by more than half the number of workers engaged before liberation, bringing total above 150,000.

British government is stated to be sponsor of new Bristol "Freighter" plane project. Craft is planned to enable rates of one shilling per ton-mile.

English-operated Reardon Smith Line is scheduled to expand its marine operations to include air services.

Obituary. Maj. Gen. Vladimir Yermolaieff, noted Russian airplane designer and prominent in engineering activities of Red Army Air Force.

"W" REFITTING "UPS" POWER OF B-19

...h installation of four new turbosupercharged 24-cyl. Allison "W" en-..., each of 3,420 cu. in. capacity and 2,600 hp., mammoth Douglas ...3—specifically XB-19A—is now chalking up higher, speedier, and ...ger flights with bigger loads. World's largest experimental bomber, this ...ying laboratory" dwarfs present superbombers with span of 212 ft. and ...gth of 150 ft. Fisher Body fitted new engines, which give 80-ton ...ber well over 25 percent additional power. New props are 16 footers, ...d nacelle design provides for use of reversible-pitch airscrews to shorten ...ding runs.

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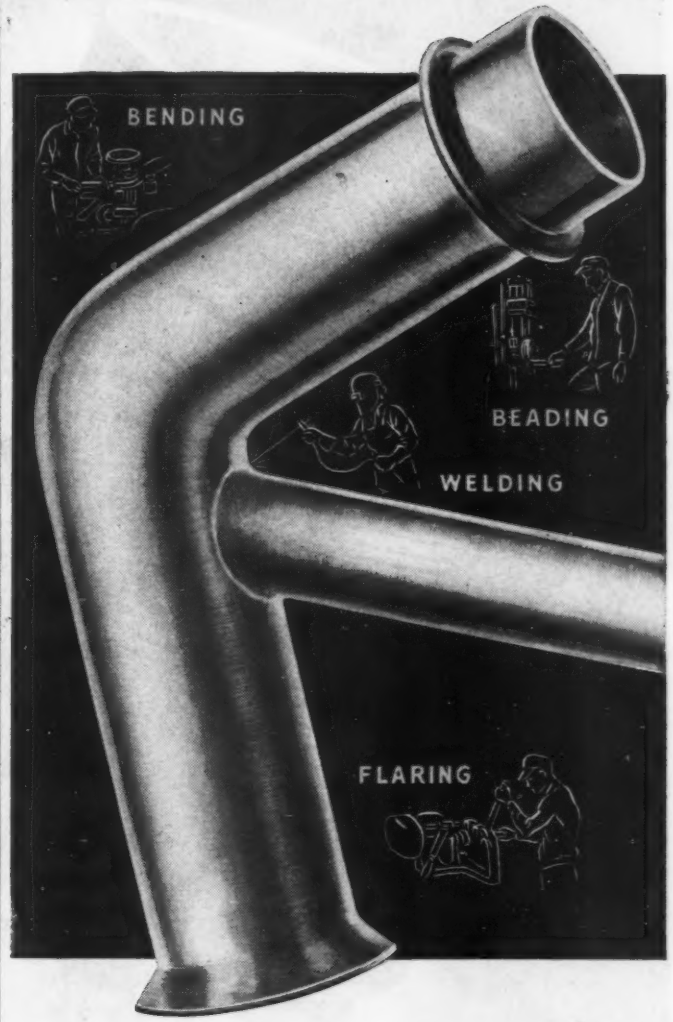

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ENGINEERING DATA

Aircraft Relays 1

Quick reference index to help locate aircraft relays to meet specifications speedily, plus dimensional drawings and other information for engineers, are features of Bulletin 30-D from Hart Mfg. Co., Hartford, Conn.—AVIATION, Feb., '45.

Stress Reduction 2

Brushing method of removing sharp edges, burrs, and marks of machining and grinding to reduce any concentration of stresses is topic of report issued by Osborne Mfg. Co., Cleveland.—AVIATION, Feb., '45.

PRODUCTION

Lock Washers 3

Bulletin from Shakeproof, Inc., Chicago, contains description and illustrates uses of company's special lock washers in conduit-junction box connections, rheostat assemblies, cable couplings, current regulators and other applications.—AVIATION, Feb., '45.

Steel Plate Fabrication 4

Operations such as precision shape cutting, stainless steel welding, and plate bending on machines developing up to 500,000 lb. pressure are shown in bulletin, *Industrial Steel Fabrication*, from Marine Fabricators Co., Perth Amboy, N. J. —AVIATION, Feb., '45.

Waterproof Glue 5

Construction Glues for Sept.-Oct., issued by I. F. Laucks Div., Monsanto Chemical Co., Seattle, Wash., contains information on new waterproof and boilproof glue called "Lauxite" PF90-C.—AVIATION, Feb., '45.

Flame Cutting 6

New color circular from Central Boiler & Mfg. Co., Detroit, describes accuracy and versatility of flame cutting. Additional annealing and grinding services offered by company are likewise covered. —AVIATION, Feb., '45.

Aircraft Wire 7

Electrical characteristics and test performances of firewall aircraft wire, developed by Rockbestos Products Corp., New Haven, Conn., are given in company's Bulletin No. 53-A. Used where wires are exposed to heat, corrosive fumes, smoke, oil, grease, or fire hazard, insulation is described as being fireproof, heatproof, and inert.—AVIATION, Feb., '45.

MACHINERY & ACCESSORIES

Air Tool Lubrication 8

November issue of magazine *Lubrication*, issued by The Texas Co., New York City, contains special articles titled *The Lubrication of Portable Air Tools.*—AVIATION, Feb., '45.

Vibration Insulators 9

Description of "Duflex" vibration insulators, plus charts indicating characteristics of these mounts, are given in circular from Harris Products Co., Cleveland.—AVIATION, Feb., '45.

Hydraulic Units 10

Bulletin 301-U from John S. Barnes Corp., Rockford, Ill., describes unit type hydraulic circuits in sizes from 1¼ to 10 hp. Simplicity of system is a feature, states company.—AVIATION, Feb., '45.

Machine Tool Catalog 11

Zagar Tool Co., Cleveland, offers new catalog containing complete information on line of collets, chucks, fixtures, broaching machines, and drill heads.—AVIATION, Feb., '45.

Multiple Drillheads 12

Adjustable drillheads of two or more spindles with positive lock are detailed in circular from Thriftmaster Products Div., Zimmer-Thomson Corp., Long Island City, N. Y.—AVIATION, Feb., '45.

Automatic Couplings 13

Stated to release torque overloads completely, automatic couplings for power transmission, made by A. Y. Dodge Co., Rockford, Ill., are described in new circular.—AVIATION, Feb., '45.

Milling Machine Tools 14

Catalog No. C10 from Kearney & Trecker Products Corp., Milwaukee, gives complete listings and information on arbors, cutters, vises, high speed attachments, and center scope for all standard milling machines.—AVIATION, Feb., '45.

Heavy Duty Live Center.....15

Designed to handle loads up to 6 tons, Model 6 MH live center is described in circular from Ideal Commutator Dresser Co., Sycamore, Ill. Ease in redressing point is stated to be feature.—AVIATION, Feb., '45.

Tool Catalog 16

Milling cutters, hobs, gear cutters, broaches, carbide tipped tools, and other special tools, are described in pocket size catalog issued by Lake Shore Tool Works, Chicago.—AVIATION, Feb., '45.

X-Ray Spectrometer 17

Stated to provide new method of making quantitative and qualitative analyses of crystalline and certain amorphous substances, Geiger-Counter x-ray spectrometer, made by North American Phillips Co., New York City, is described in new circular.—AVIATION, Feb., '45.

V-Belt Conversion Chart 18

B. F. Goodrich Co., Akron, has issued handy conversion chart on fractional hp. v-belts, giving size and conversion data on standard "O", "A", and "B" section belts for compressors, grinders, blowers, and industrial machinery.—AVIATION, Feb., '45.

Hydraulic Foot-Hand Pumps 19

Considered in Bulletin 138 from Lyon-Raymond Co., Greene, N. Y., are hand- or foot-operated hydraulic pumps offered by company. Pump specification table is included. An engineering service is also offered.—AVIATION, Feb., '45.

Electric Hand Tool 20

Titled *More Power To You*, circular from Precise Products Co., Racine, Wis., describes No. 35 high-speed electric hand tool designed to operate at 35,000 rpm., developing 1-6 hp., and weighing 35 oz. Tool is used for special grinding, milling, deburring, polishing, and small dia. drilling. It may be mounted in vise, on stand or lathe, or used alone.—AVIATION, Feb., '45.

ELECTRICAL

Insulation Resistance Measure 21

Indicating only current which passes through insulating material, measuring units made by Leeds & Northrup Co., Philadelphia, are described in publication *To Measure Insulation Resistance—L&N Test Set Assemblies.* Detailed is one set for routine plant use, another for laboratory work.—AVIATION, Feb., '45.

AVIATION READER'S SERVICE

FEBRUARY 1945

AVIATION, 330 W. 42nd St., New York City 18

Please send me additional information according to key numbers circled.

INFORMATION TIPS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

NEW PRODUCTS 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

NAME..... TITLE.....

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ADDRESS.....

Iron Core Data 22

Covering uses and functions of powdered iron cores; permeability and "Q" of various materials at different frequencies; effects of addition of adjusting screws, copper cores; mechanical considerations; standard pieces and sizes; and special cores particularly of large dimensions, catalog from L. Crowley & Co., West Orange, N. J., offers source of practical data.—AVIATION, Feb., '45.

Welding Electrodes 23

Resistance Welding Electrodes and Alloys is title of new catalog from P. R. Mallory & Co., Indianapolis, Ind. Featured are data on line of electrodes and holders, a list of "do's" and "don'ts", and applications and properties of company's alloys.—AVIATION, Feb., '45.

Tachometers 24

Containing full-face and profile views of four models of its individual-mount tachometers and a multi-range portable hand tachometer, Bulletin No. 44-1 from Jones Motrola Co., Stamford, Conn., also gives rpm. ranges available, mounting dimensions, information on use and operation, and general installation data.—AVIATION, Feb., '45.

Molded-Insert Chart 25

Offered by American Phenolic Corp., Chicago, is chart of molded AN arrangements for electrical connectors designed to enable engineers, knowing required number and sizes of wires, to make selections quickly.—AVIATION, Feb., '45.

Glass Insulation 26

Uses, effectiveness, and efficiency of "Fiberglas" electrical insulation materials are detailed in Catalog No. EL44-7 from Owens-Corning Fiberglas Corp., Toledo, Ohio. Characteristics and applications of this material in wire, tapes, tubing, and other forms, are given.—AVIATION, Feb., '45.

Ray-Bans IN WAR SERVICE

GLARE PROTECTION FOR "SEA BIRDS"

The blinding dazzle of the burning sun proves no handicap to the Coast Guard "Sea Birds" who serve on convoy escort duty. Cool, comfortable Ray-Bans, developed by Bausch & Lomb before the war, filter out glare-producing rays and transmit useful light to aid in the unrelenting search for menacing submarines and planes.

Today the entire Ray-Ban output goes to our Armed Forces. After the war, the skilled men and women at Bausch & Lomb will again produce for civilian use the special Ray-Ban glass, grind and polish the scientific lenses and fashion the distinctive frames. Look forward to that day when you will be able to get genuine Ray-Ban Sun Glasses and Shooting Glasses.

All Ray-Ban Sun Glass production is allocated to military use.

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BAUSCH & LOMB IS DESIGNER AND PRODUCER OF BINOCULARS, SPOTTING SCOPES, RAY-BAN SUN GLASSES AND A COMPLETE LINE OF OPTICAL INSTRUMENTS

PLASTICS

Coater Machine 27

Designed to properly melt plastic coatings used for protecting parts and tools for storage or shipment, machines made by Youngstown Miller Co., Sandusky, Ohio, are described in company Bulletin YM-800.—AVIATION, Feb., '45.

Protective Coating 28

Titled *Amercoat No. 33 Plastic Coating*, folder from Amercoat Div., American Pipe & Construction Co., Los Angeles, contains data on use of material to protect equipment and structures from corrosion.—AVIATION, Feb., '45.

Brochure on Plastics 29

Celanese Plastics, new color brochure issued by Celanese Plastics Corp., Div. Celanese Corp. of America, is generalized booklet which includes references to uses of Lumarith in aviation applications. Numerous descriptive tables and photographs are offered.—AVIATION, Feb., '45.

NEW PRODUCTS

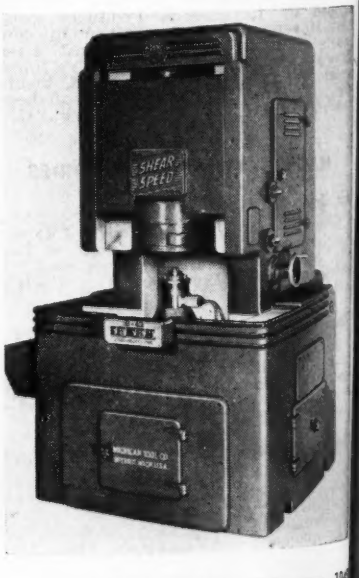
Latest Machine Tools

Press for Plate Work 30

Developed by **Watson-Stillman Co.**, Roselle, N. J., for heavy plate work, new 500-ton flanging (joggling) gap type hydraulic press has high and low pressure delivery pump driven by 20-hp. motor, and capacity of 103 gpm. at low pressure and 14.7 gpm. at high, with operating pressure up to 2,900 lb. per sq. in. Vertical or main ram has capacity of 500 tons, stroke is 12 in., depth of throat 28 in., size of moving platen 36 x 36 in., and bed size 66 x 55 in. Horizontal ram capacity is 250 tons, stroke is 7 in., and clamping platen 24 x 24 in. Operating speeds of vertical ram: Advance 68.5 in./min., pressing 9.8 in./min., and return 106 in./min. Operating speeds of horizontal ram: Advance 135 in./min., pressing 19 in./min., and return 150 in./min. Height of press is 14 ft. 6½ in. Floor space specification is 5 ft. 6 in. x 10 ft. 10 in. Weight is 80,000 lb.—AVIATION, Feb., '45.

New Gear Cutting Process 31

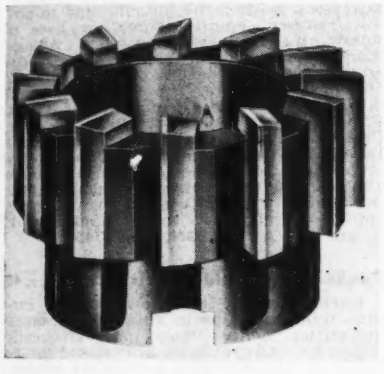
Objective in development of "Shear-Speed", new gear cutting process of **Michigan Tool Co.**, Detroit, was to bring speed of gear cutting up to level set by modern gear-finishing machines, and it is stated that new process is capable of rough and semi-finish cutting of as many as 60 to 100 or more gears per hour. Machine cuts all gear teeth simultane-



ously with radially fed form-tool blades having shear-cutting action with balanced cutting pressure around gear. Illustration shows interior of cutter head and tool blades. In operation, gears are placed on work holder. Chucking is part of automatic machine cycle. Operator presses button to start machine, and when cycle is completed there is return to loading position automatically and release of finished gear. When gear is automatically clamped, head of machine containing cutter head lowers into cutting position and automatically locks. Work now recriprocates vertically. At beginning of each up-stroke all blades are advanced radially an equal amount. On return stroke, blades are retracted slightly to provide clearance. Amount that blades are fed into work on each stroke is adjustable. Correct sizing of work is automatically controlled and adjustable. "Jog" control is provided on machine to inch it for set-up adjustments. Adjustments for speed of vertical reciprocation and length of stroke are also provided. Entire inner cutter head is removable as unit. Shoulder gears, spur gears and helical gears can be cut. Photo shows Model 1843, designed for rough- and semi-finish, which cuts gears up to 4-in. dia. and 2-in. face width. Machine is seen in upper (loading) position.—**AVIATION, Feb., '45.**

Shell End Mills.....32

Haynes Stellite Co., unit of Union Carbide & Carbon Co., Kokomo, Ind., announces small standard shell end mills



with brazed-in blades. Diameters range from 1¼ to 6 in., with face thicknesses from 1 to 2¼ in.—**AVIATION, Feb., '45.**

Shop Equipment & Materials

New Molded Laminate.....33

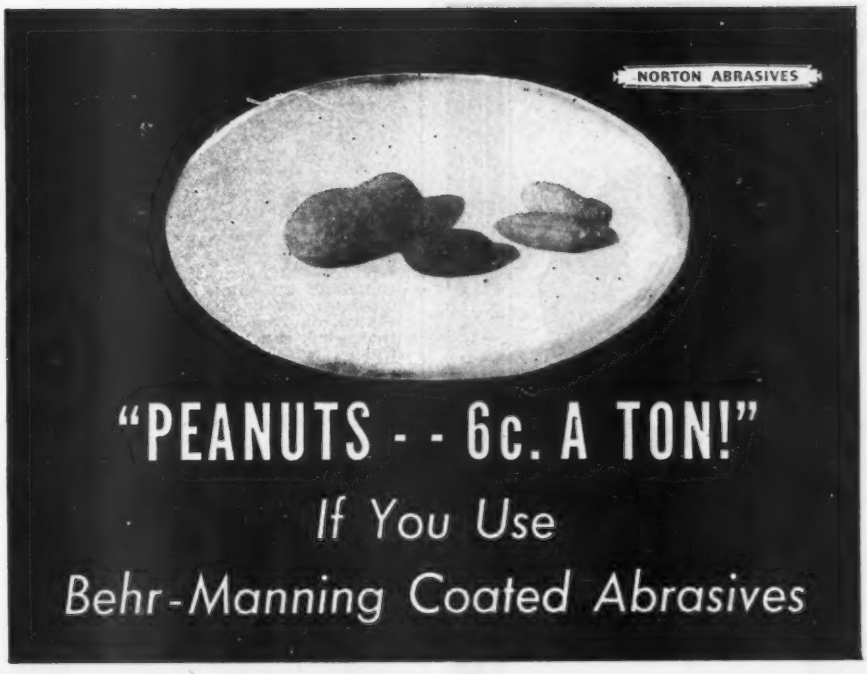
Used in aircraft for nonstructural and semistructural members, Micarta 444, new molded laminate developed by **Westinghouse Electric & Mfg. Co.**, Pittsburgh, is described as having desirable molding properties of thermoplastic materials and good physical characteristics of thermosetting materials. Modification of resin in standard product causes substance to soften when hot but at the much higher temperature of 300 deg. C., permitting material to be pressed into deep-drawn shapes at pressures of 50 to 100 lb. Dies may be made of hard wood or thermosetting laminates.—**AVIATION, Feb., '45.**

AN 442 Rivet Set.....34

Aero Tool Co., Burbank, Calif., announces new rivet set for use on AN 442 rivets. Featured are cups "coined" for dimensional accuracy, available in all standard sizes of straight and offset.—**AVIATION, Feb., '45.**

Annealing Compound.....35

Used in deep drawing of brass and steel, new dry drawing and annealing compound No. 268, manufactured by **Plasteel Corp.**, Ecorse, Mich., is applied in varying strengths to give nearly imperceptible wax coating. Applied in drum or spray



A large producer of peanuts and peanut products had long suffered from high cost and the time required to remove their red skins. Now, that's all changed.

At the suggestion of a Behr-Manning field engineer, Garnet Paper as an abradent was tried with immediate and almost incredible improvement in both speed and economy.

In a hopper at one end of the machine, the nuts lie in their red hulls. The power is thrown on and almost instantly from the other end emerges a mixture of cleaned nuts and skins, whence a suction line whisks away the loose hulls, and the clean, white peanuts fall into a waiting receptacle.

The Garnet Paper involved costs six cents and cleans a ton of peanuts before it has to be changed.

You may not be interested in peanuts, but the same engineering skill and knowledge which enabled our man to contribute to this successful result, are available to *you* to improve jobs you're now doing or to suggest entirely new uses for Coated Abrasives in your operations.

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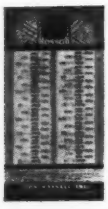
RELIABLE COATED ABRASIVES SINCE 1872

ADAPTABILITY

...used to doing the unusual

Does some part of the product you make present an unusual problem? You are under no obligation when you ask our consultant service for help. Our engineering thinking and our machines are both adapted to doing the unusual. And chances are that a cold-forged part will be more economical for you.



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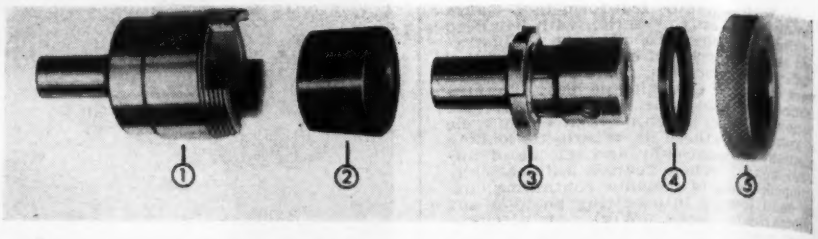


type mechanical washer, coating contains sufficient annealing compound to prevent formation of hard mill scale. Coating is easily removed in pickling. It is stated that work can be drawn as it comes from washer without use of coolant or added lubricant.—**AVIATION, Feb., '45.**

New Forming Fiber 36

New "Phemolastic" fiber, developed by **Taylor Fibre Co.**, Norristown, Pa., is essentially fabric-base phenol fiber made more elastic by special weave in base

material and rearrangement of the resin formula and coating procedures. Using inexpensive wooden molds, it is stated that flat sheets may be changed to conform to almost any bend, curve, or draw, within a few minutes.—**AVIATION, Feb., '45.**

Waterproofing of Metal Joints 37

Containing pigments with rust inhibiting qualities, No. 3909 "Dolfinite" chromate sealer is material designed for water and airproofing of all types of metal joints and for spot welding seams. Stated to withstand variance of temperature down to minus 60 deg., it is easily applied with knife or hand or air pressure gun states maker, **Dolphin Paint & Varnish Co.**, Toledo, Ohio.—**AVIATION, Feb., '45.**

New Quick-Fastening Lock Nut 38

Adel Precision Products Corp., Burbank, Calif., offers "Stalock" (photo below) quick-fastening lock nut designed to offer 360 deg. contact with screw threads. Its spring action is described as causing contact surfaces to be forced deeper into thread channels, to afford greater locking action. Wide variety of nuts are furnished in two types: For sheet metal screws, standard sizes 4, 6, 8, 10, and 14; and for coarse machine screw threads sizes 6, 8, 10, ¼ in., and ⅜ in. Special sizes and shapes may be ordered.—**AVIATION, Feb., '45.**

Flexible Tool Holder 39

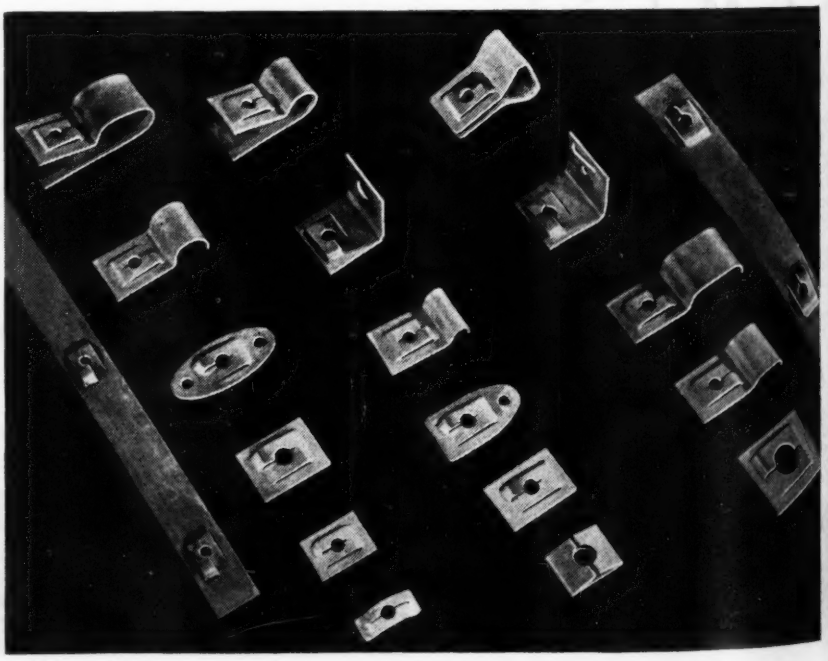
Utilizing a simple oil-resistant synthetic rubber insert as a "universal joint" in which tool floats, "Tool-Flex", new flexible tool holder announced by **Richmont, Inc.**, Los Angeles, consists of five parts. Photo above shows model for turret lathe, straight shank, where (1) is body or shank, (2) rubber insert, (3) holder, (4) rubber grommet, and (5) retainer cap. Holder is designed as follow-up tool. It is stated to compensate for parallel and angular misalignment of turret head or tail stock with lathe spindle, and to permit reamer, counter-borer, or hone to follow and relieve side pressure. Adjustment of retainer cap increases or decreases counter action of rubber insert. Holders are made for large and small lathes with turret heads, engine lathes, drill presses, tappers, and portable drills. Chuck arbors, reamer holders, and Morse taper sleeves are interchangeable in any style body of same size. Holders are available with straight shanks ½ to 2 in., female taper 2-A or 33 for drill press spindles, and Morse taper shank sizes 3, 3, and 4.—**AVIATION, Feb., '45.**

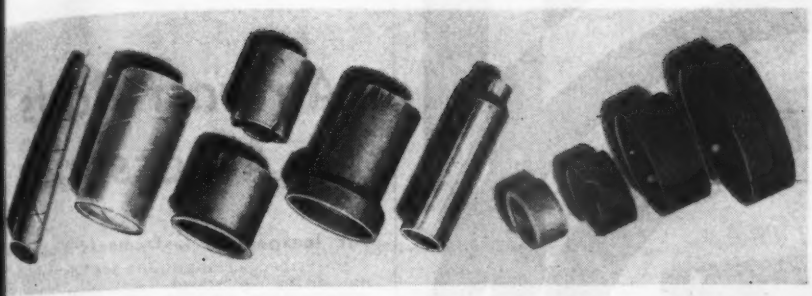
Packaged Carbide Tools.....40

Carboloy Co., Detroit, announces carbide tools and tips in standard packages, quantities being those most frequently ordered. Advantages are stated to be speed in filling orders and safety in shipment; for example, cutting tips of all standard tools are dipped in hot plastic which hardens into protective coating and is removable when slit with knife. Standard containers are treated to resist moisture and are reinforced by metal stapling. Colored labels provide identification.—**AVIATION, Feb., '45.**

Thread Protectors 41

Made from spiral-wound fiber, Kraft

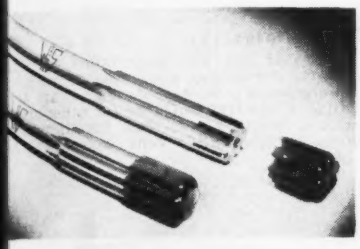




aper, or cellulose acetate, new thread rotectors and dust caps of any shape r size (photo above) are designed for reater durability in protecting fittings, xposed openings and ends, tubing, and ther products, from moisture, rust, dirt, rit, or damage in packing, storing, or hipping. Maker is **Precision Paper Tube o.**, Chicago.—**AVIATION, Feb., '45.**

arbide Tool Covers 42

Wendt-Sonis Co., Hannibal, Mo., an- ounces new protective covering for its arious carbide tipped tools. In plastic



rm, covers afford protection in ship- ent and storage of the tools.—**AVIA- ION, Feb., '45.**

Electrical Appliances

oil Insulation 43

Method for vacuum-under-pressure im- regnation of coils, armatures, and trans- rmers has been developed by **Vacuum mpregnating Works**, Chicago. Insulation aterial is suited to each individual type impregnation work planned.—**AVIA- ION, Feb., '45.**

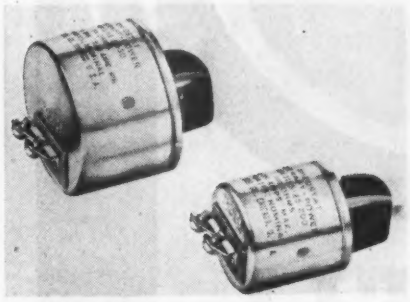
idget Relay.....44

Developed for aviation applications, Koroseal" midget type relay manu- ctured by **Betts & Betts**, New York City, hermetically sealed in metal shell with ntent of dry air, inert gas, or pressur- d content as desired. Unit is 1 1/2 in. g (2 3/8 in. including prongs) weighs 4 , and has standard octal plug base. Coil indings can be supplied for voltage

ranges from 1.5 to 70v. d.c. Magnetic circuit is stated to permit satisfactory operation even with coil voltage fluctuations as great as 25 percent.—**AVIATION, Feb., '45.**

Aircraft Rheostats 45

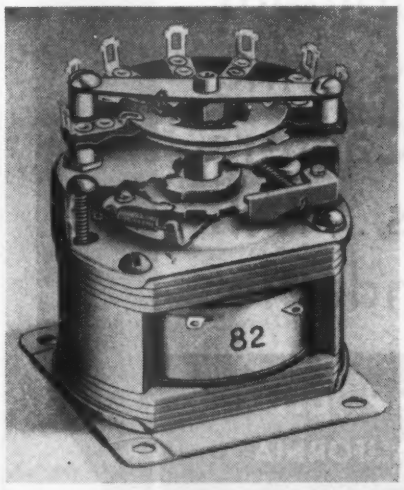
Featuring new and improved control protection, two power rheostats for aircraft, made by **Ohmite Mfg. Co.**, Chicago, are described as rugged and light in



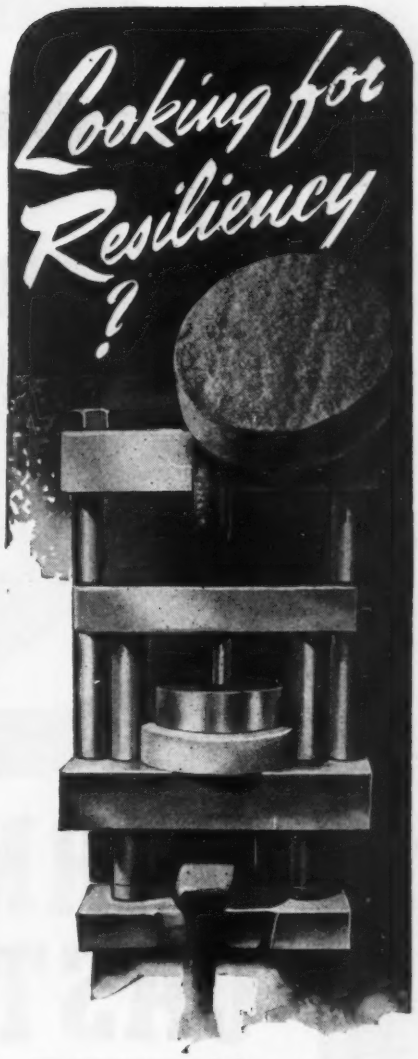
weight. Designed for operation in temperature range from minus 55 deg. C. (minus 67 deg. F.) to plus 70 deg. C. (plus 158 deg. F.), units are made in 25 and 50w. sizes, linear or taper wire wound, in various resistances, and are totally enclosed in metal container. Pictured are aircraft rheostats for latest AN-R-14a (drawing AN3155) specifications.—**AVIATION, Feb., '45.**

Rotary Relay.....46

Operating a shaft extension through 360 deg. in 12 progressive steps, Type 82 relay stepping unit, made by **Price Bros. Co.**, Frederick, Md., provides a 12-posi-



tion selector switch which indexes one position for each momentary current impulse. Unit will drive up to three wafer switches or other load not in excess of 12 oz.-in. torque, and can be made to operate clockwise or counter-clockwise. Actuator can be furnished as direct drive, indexing load with current impulse, or as spring drive, indexing load following impulse. Current required depends on torque, so suitable coil is furnished when load is specified. Unit operates on direct current only, states maker.—**AVIATION, Feb., '45.**



IN EXTENSIVE laboratory tests, the compression of certain (½-inch thick) Booth felt samples under load of 150 lbs. per sq. in. resulted (after load removal) in "permanent" loss in thickness of only .005 inch!

Yes, Booth "prescription" felt manufacture can be controlled to give you the amount of resiliency, or almost any other quality, desired in your material.

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Aircraft Parts & Accessories

For Inexpensive Instruments 47

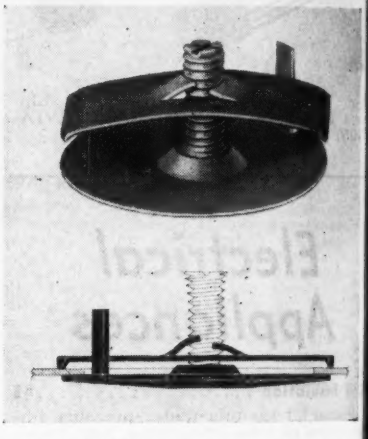
Described as adaptable for instruments measuring airspeed, altitude, gasoline consumption, and other factors in operation of personal aircraft, and as accurate though inexpensive, new pressure-gage mechanism features a cam and helicoid movement, stated to open new field in gage construction. Maker is **Certified Gauge & Instrument Co.**, Long Island City, N. Y.—AVIATION, Feb., '45.

Free-Air Thermometer 48

Designed for and supplied to AAF by **Scott Aviation Corp.**, Lancaster, N. Y., free-air thermometer is now available to others. Described as rugged and accurate, it may be installed in few minutes.—AVIATION, Feb., '45.

Cover Plates.....49

Designed for patching bullet holes in aircraft, speed nut cover plates made by **Tinnerman Products**, Cleveland, are now available in sizes suitable for other applications, such as covers for inspection doors, access and vent holes, and to



seal holes left after alterations or removal of equipment. Attachment is by sliding one end of speed nut into hole, centering plate, and tightening screw. Three sizes fit wide range of panel thicknesses and cover holes of $\frac{3}{8}$, $1\frac{1}{8}$, and $1\frac{5}{8}$ in. dia. Other sizes may be had on special order. —AVIATION, Feb., '45.

ANNOUNCEMENTS—

of new machine tools, shop equipment and materials, electrical appliances, and aircraft parts and accessories are invited for inclusion in these columns.

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable, and whenever possible glossy-print photos should be enclosed. Please do not send electros.

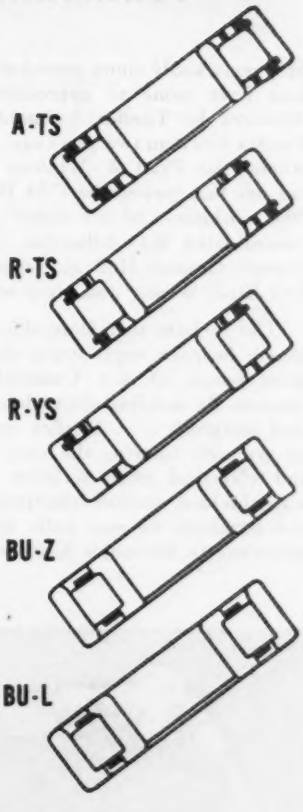
Manufacturers should address announcements to—

New Products Editor,
AVIATION
330 W. 42d St., New York City 18

Hyatt Hy-Load Bearings are made in separable types as well as in self-contained units. In the separable bearings the inner races are the separable units in one instance and the outer races in the other. Thus, the component parts of every separable Hyatt Hy-Load type bearing of a given size are fully interchangeable. Every race fits every roller assembly.

Separable races may be assembled in one part of the shop and the rest of the bearing in another. When the sub-assemblies are brought together on the final assembly line the component bearing parts will fit correctly. No selection or matching required.

Every Hyatt A-TS, R-TS, R-YS, BU-Z and BU-L type bearing has this feature—and many others. Write for data.



HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION

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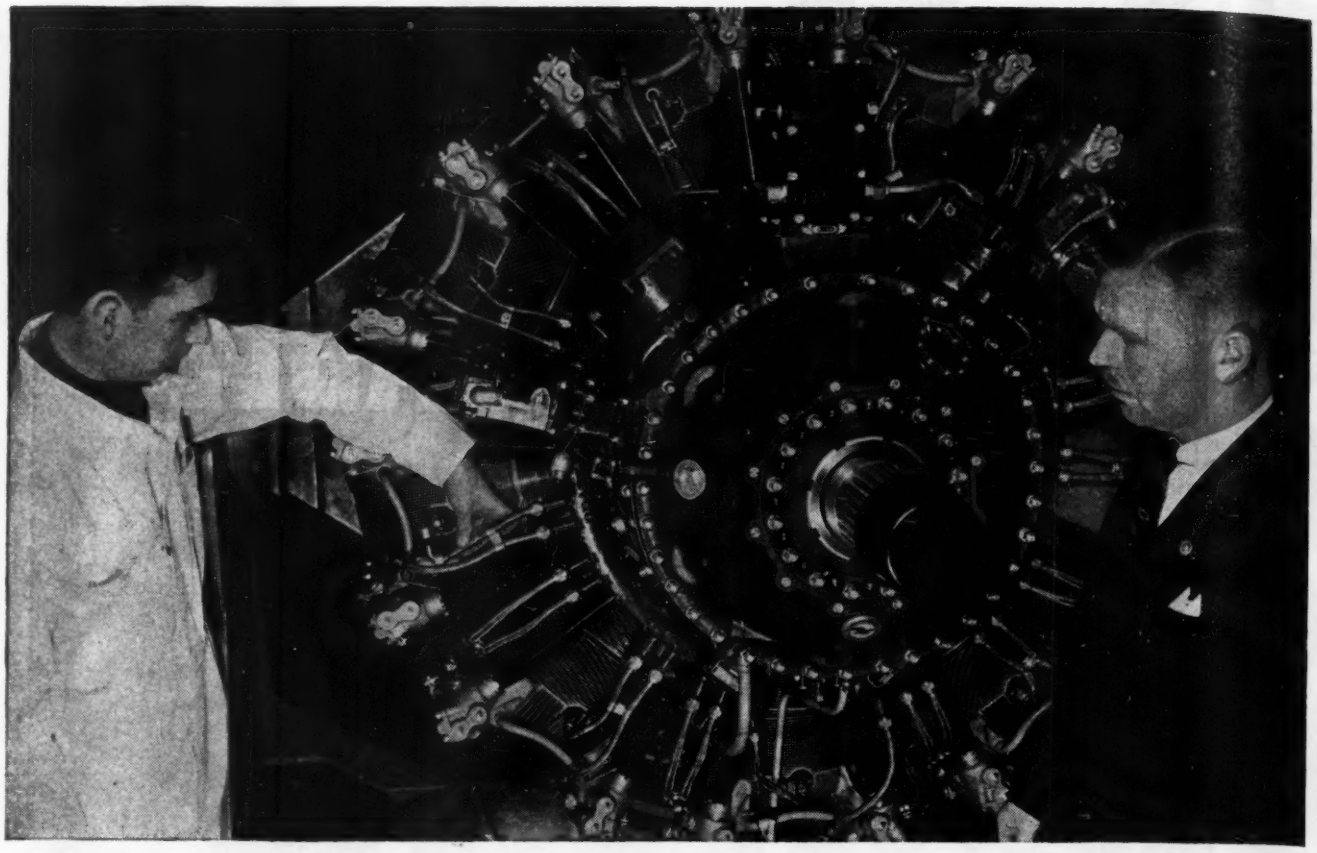

MECHANIC: *"Great leads, Pete... we almost never replace one!"*

FOREMAN: *"Nothing unusual, Joe... they're Titeflex Unimold leads!"*

In a remarkably short period of time, engineers and maintenance men have come to appreciate the outstanding performance delivered by Titeflex Unimold ignition leads. Introduced by Titeflex less than two years ago, today you'll find them on, among others, the Pratt & Whitney 2800, 1830, and R-2000 series engines that power the C-54 Douglas Skymaster, Douglas C-47 "the workhorse of the Army", PB2Y Consolidated Coronado, Consolidated B-24 Liberator (Navy Version), Chance-Vought Corsair, Gruman Hellcat, Republic P-47 Thunderbolt, Northrop P-61 Black Widow and many others.

The acclaim that Unimolds have won can be traced to the sound, *bedrock* engineering that went into the development of the Unimold manufacturing process. By molding the various elements of the lead *integrally* . . . Titeflex engineers produce an assembly offering the very best mechanical and electrical characteristics in combination with shielded conduit, electrical conductor and end terminals in one unit. Each assembly is subjected to thorough X-ray and electrical inspection tests before being shipped. Thus it is made absolutely certain that the conductor is molded in the precise center of the insulating compounds and that these vital ignition leads will not fail electrically in service.

Titeflex Unimolds perform equally well in auxiliary applications, and many of them are being used with gasoline driven generators and gasoline aircraft heaters. Titeflex engineers are available for consultation on any aircraft ignition or other shielding problem. A letter will bring you details.

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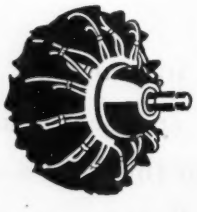
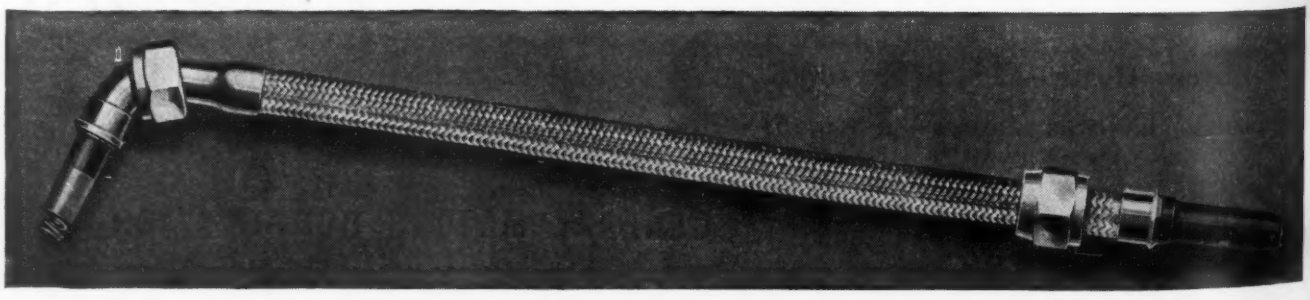
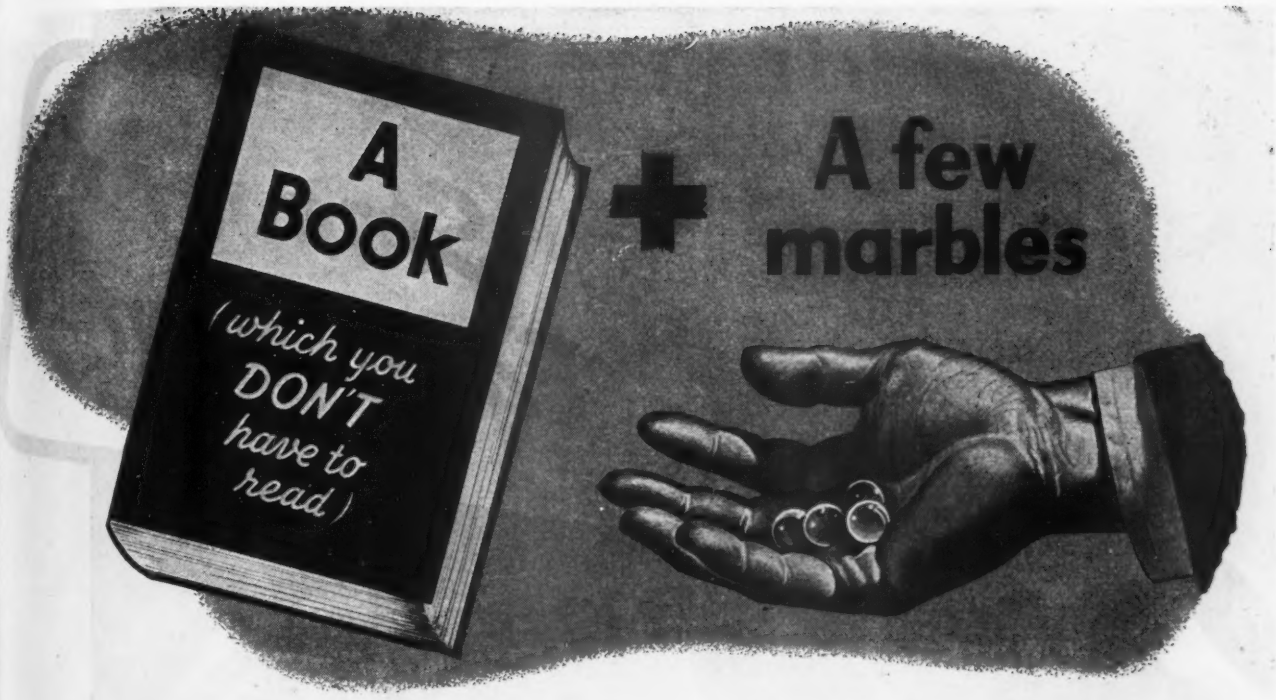


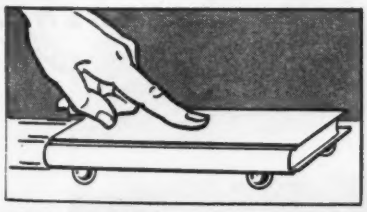
Titeflex





tells the WHY of Ball Bearings

TRY THIS: Place a book on your desk and your hand firmly on it. Then try to push the book across the desk. That's the principle of *sliding motion*—hard on book, desk and energy.



THEN THIS: Place 4 marbles under the book, your hand on top—and push. The marbles roll freely, the book moves easily in any direction. That's *rolling motion*—smooth and easy on everything!

Cut-away view of New Departure Ball Bearing

There is a simple, fundamental truth in the principle of the ball bearing: "Nothing Rolls Like a Ball!"

The ball possesses inherent advantages unequalled by any other rolling body. There are no *ends* to a ball—so its axis of rotation need never be artificially fixed.

Thus, a *Ball* bearing bears the loads on a circle of *free rolling* steel balls, reducing friction and wear, maintaining precise location of parts and cutting maintenance time—as does no other type bearing.

That is why over 300 million New Departure Ball Bearings are at work in this war. *That* is why designers of peace-time machinery are designing more ball bearings into their machinery than ever before.

There is really no substitute for the ball bearing—nor any substitute for the technical experience and creative engineering that go into New Departure Ball Bearings.

Ask for your free copy of "Why Anti-friction Bearings?"

nothing rolls like a ball

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PHOTOGRAPH FOR CULVER AIRCRAFT CORP. BY ROBERT YARNALL RICHIE

YOU'LL find Sensenich propellers as standard equipment on nine out of ten new aircraft under 250 hp.

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Ask your aircraft parts supplier or write direct for list showing Sensenich model numbers for all planes including government ships now being sold. SENSENICH BROTHERS, Adjacent to Lancaster Municipal Airport, Lancaster, Pa. West Coast Branch, Glendale, Calif.

* * *

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★ The price of an aluminum casting is often only a fraction of the cost of finishing it. And it is in reducing your finishing cost that Permite Permanent Mold Aluminum Castings offer you important savings. Permanent mold castings are more precise in dimension (tolerance is ± .01" against ± .03" in sand castings). And because every casting is poured in the same permanent metal mold, all castings are dimensionally uniform.

These cost-saving precision features mean less rough weight in the casting — less metal to remove. You do not have to readjust finishing machines to meet variations in the castings. Even automatic, multiple-operation machines can be safely used with Permite Permanent Mold Castings. You may also have fewer surfaces to machine; the finished cost per casting is often surprisingly low.

Aluminum Industries' first products — 25 years ago — were permanent mold aluminum castings. Today, no foundry is better equipped to turn out castings of this superior type. Experience has given us a thorough knowledge of aluminum and its alloys. And the specialized knowledge of our engineering staff is always at your service. We shall be glad to submit recommendations, upon request.

ALUMINUM INDUSTRIES, Inc.
CINCINNATI 25, OHIO

Detroit: 809 New Center Building
Los Angeles: 324 North San Pedro Street
Chicago: 616 South Michigan Avenue
New York: 9 Rockefeller Plaza

PERMITE ALUMINUM ALLOY CASTINGS

A Lightning Start for the "Thunderbolt"... with a MALLORY Rectostarter*

The mobile Mallory Rectostarter at left provides ample DC power to start the engine of this P-47 "Thunderbolt". The Rectostarter may also be used for battery charging, testing and repairing aircraft, electrical and radio equipment wherever airports are wired for this service.

For Speedy Plane Servicing Wherever Airports are Wired for Service

STARTING the 2000-horsepower engine that powers a Republic P-47 "Thunderbolt" is sure-fire with DC current supplied by a dependable Mallory Rectostarter.

Mobile, rugged, easy to operate, unaffected by variations in the weather, the Rectostarter is built to give years of trouble-free service. They are built to operate from any 208 and 230 or 460 volt 3 phase 60 cycle AC source to furnish an economical, continuous flow of DC power. Rectifying action is provided by Mallory magnesium-copper sulphide rectifiers. With no moving parts, these dry disc rectifiers assure silent operation and long life.

Republic Aviation Corporation—like other aircraft manufacturers and the airlines—finds many uses for Mallory Rectostarters. Starting engines . . . providing power for radio, instruments, lights and other equipment in the plane while on the ground . . . testing aircraft engines and electrical equipment during manufacturing operations . . . these jobs are commonplace for the Rectostarter. All this and battery charging, too, for it can be used to taper charge 12 and 24 volt aircraft batteries without removing them from the plane . . . wherever the airplane may be on airports wired for this service.

Rectostarters are available in portable or stationary units, with one or more DC outlets. See your nearest Mallory Distributor for details. Or write us today.

P. R. MALLORY & CO., Inc.
INDIANAPOLIS 6, INDIANA

*Rectostarter is the registered trademark of P. R. Mallory & Co., Inc. for rectifier units for use in starting internal combustion engines.

P. R. MALLORY & CO. Inc.
MALLORY RECTIFIERS

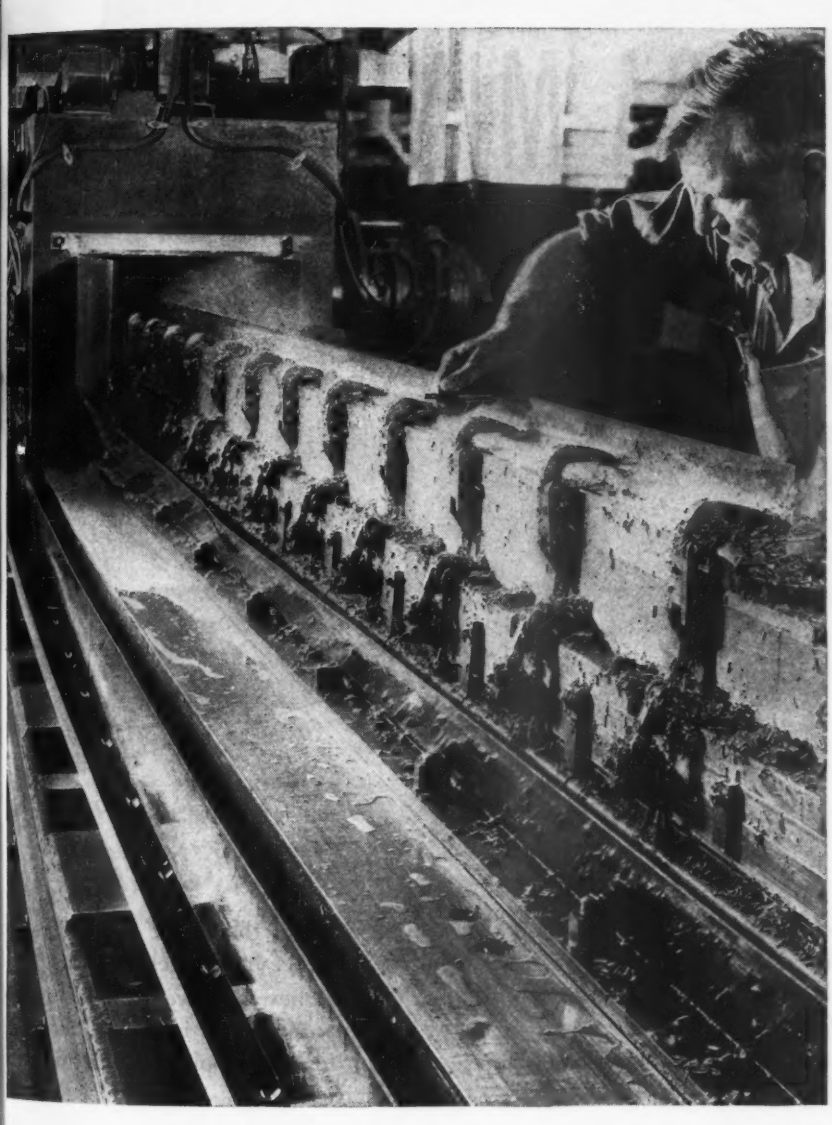
MAGNESIUM COPPER SULPHIDE RECTIFIERS—
STATIONARY AND PORTABLE D. C. POWER SUPPLIES—
BATTERY CHARGERS AND AVIATION RECTOSTARTERS*

PRODUCING WING SPARS ON SHORT ORDER

By WILLIAM WINTER

Editor of "Air Trails" and author of "War Planes of All Nations" tells how Bell Aircraft has developed a spar milling machine that in twenty-two minutes does the job that once required twenty-four hours.

"THE Bell-designed spar milling machine is one of the great contributions this progressive company has made to speed up American aircraft production. Previous to the development of this mill, now being used by Bell and many other aircraft companies, it required twenty-four hours to complete a wing spar. Now these ingenious machines, covered by Bell Aircraft patents, turn out the spars for the giant Boeing B-29 Superfortresses being built in the Marietta Bell Aircraft plant in twenty-two minutes.



"The Bell spar milling machine, first developed in 1940, makes a cut two inches deep and four inches wide at the rate of sixty-five inches per minute.

"Under the old, slow method the material was fed into stationary cutter heads. In the Bell-designed mill the cutter moves across the metal, which is securely held to a bed by clamps that automatically drop down to let the cutting machinery pass and then jump up to grip firmly the spar behiud the moving section.

"Since the cutting head runs on a cam which acts as a die, the machine cuts any contour up to twenty degrees.

"Each machine is its own meticulous housekeeper, for streams of coolant pumped onto the high speed cutter heads sweep away the shavings and deposit them into a central salvage pit.

"The advanced design which Bell engineers have built into this spar milling machine are further evidence that American 'know how' is the prime factor that now makes this country the greatest air power in the world.

"And when V-day dawns, this same engineering ability will be utilized in producing peacetime products that will bring this nation better living and greater values."

★ *Buy War Bonds and Speed Victory* ★

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL...EAST COAST, INC.

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

© Bell Aircraft Corporation

NIAGARA FRONTIER DIVISION
Buffalo and Niagara Falls, N. Y.
Airacobra (P.39) and Kingcobra (P.63)—Fighters
Airacomet—America's First Jet Propelled Plane
The Bell Helicopter

ORDNANCE DIVISION
Burlington, Vt.
Flexible Gun Mounts and other ordnance materials

GEORGIA DIVISION
Marietta, Ga.
B-29 Boeing Superfortress

War shortages crop up in strange materials. Mica, for instance. Once seen principally in the windows of stoves, and in small boys' pockets, it is now used extensively as electrical insulation. In some war products, it is virtually indispensable: capacitors for radio, spark-plugs for airplane engines, insulators in electronic tubes.

With demand mounting, manufacturers were desperate. A four-man technical mission flew to London to help ration the world's supply between the United States and Great Britain. The shortage was serious.

The War Production Board, convinced that much mica was classified too low when judged by appearance alone, asked Bell Telephone Laboratories to develop a new method of electrical tests. The Laboratories were able to do this quickly and successfully because of their basic knowledge and experience in this field.

The new tests were made available to manufacturers in this country and abroad—the supply of usable mica was increased 60% — and a difficult situation relieved.

Skill to do this and other war jobs is at hand in Bell Laboratories because, year after year, the Laboratories have been at work for the Bell System.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for our Armed Forces at war and for continued improvements and economies in telephone service.

MR. ENGINEER...66 years is a lot of leather

In 66 years of processing leather to protect and seal machine parts, Chicago Rawhide has solved again and again the toughest problems posed by the inventive genius of America's top industrial engineers. Three factors are responsible for the success of Sirvis leather products . . . the solid foundation of knowledge about mechanical leather which is Chicago Rawhide's greatest asset . . . the custom-built designs developed by research engineers who have learned that each new problem needs special consideration . . . and the rigid laboratory control in every stage of production, which insures absolutely uniform performance under all service conditions.

If protection is your problem, why not draw upon this unparalleled reservoir of specialized engineering experience? If your postwar designs include parts where irregular, eccentric or universal action makes a rigid seal impractical . . . a Sirvis leather boot may be the answer. If unusual precision, resilience, long service or resistance to pressure, shock, or vibration is demanded in packings, washers, gaskets, couplings or valve discs . . . Chicago Rawhide research can develop the properties you require, and careful production control can assure the most exact processing. For precision performance in protective coverings and seals, specify Sirvis mechanical leather.

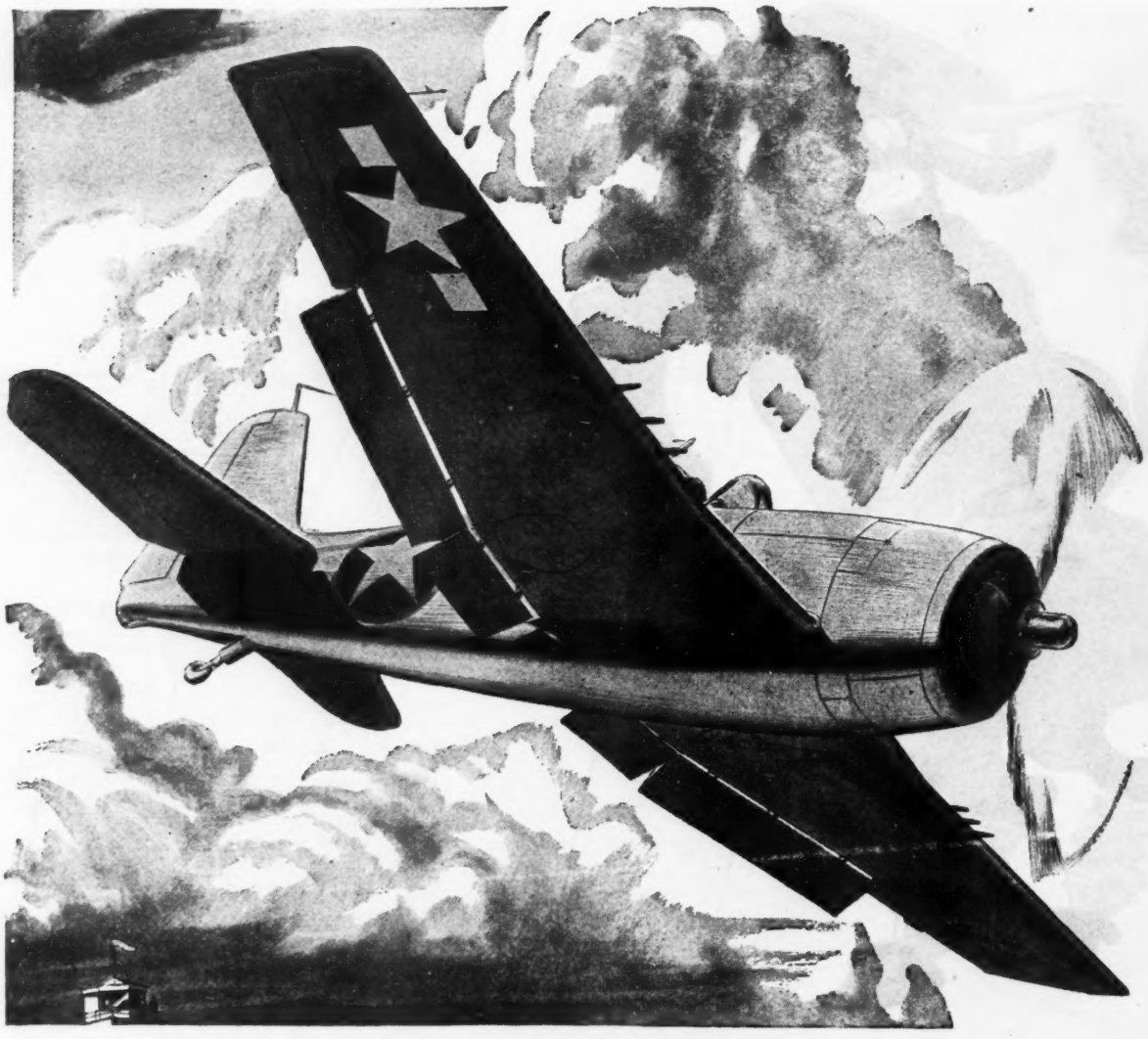
sirvis

A Product of

CHICAGO RAWHIDE MANUFACTURING CO.

1305 Elston Avenue **Chicago 22, Illinois**

New York • Philadelphia • Detroit • Los Angeles • Cleveland • Boston
Pittsburgh • San Francisco • Cincinnati • Portland • Syracuse • Peoria



HOW TO TURN A PANCAKE . . .

into a perfect 3-point landing!

No need for a perilous pancake landing when a fighter plane returns to base—though enemy bullets may have wrecked the hydraulic supply line that controls the retractable gear.

Aboard the plane, there's a compact storehouse of emergency power —a Kidde cylinder of compressed carbon dioxide! The pull of a handle releases the stored energy of this highly compressible gas —sends carbon dioxide coursing through an emergency supply line to operate the retractable gear. Down come the wheels for a routine 3-point landing.

This is one of the many tasks that gases-under-pressure, stored in light-weight Kidde cylinders, are performing in the aviation industry. Specialists in power actuation by compressed gases, Kidde engineers are ready to work with you in adapting this compact source of energy to *your* specific problems. Just drop a line to our Research and Development Department.

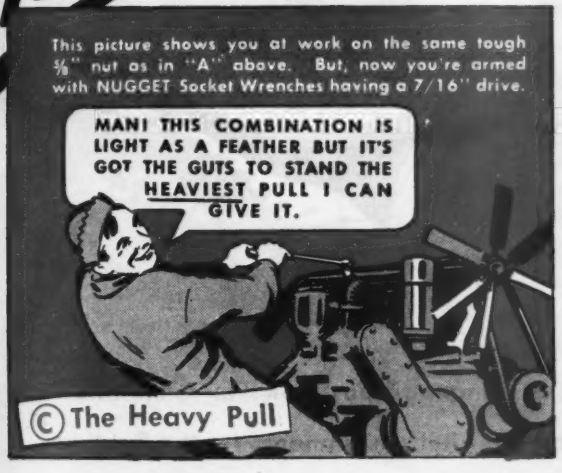
K Kidde

Walter Kidde & Company, Inc. • 140 Cedar Street, New York 6, N. Y.

Are You Doing It *This* Way, Now?

HM-M-M! HERE'S ANOTHER 5/8" NUT — BUT NOW I BETTER SHIFT TO MY 3/8" DRIVE BECAUSE A 1/2" DRIVE SET-UP WOULD NEVER GET IN THERE.
Ⓑ The Tight Spot

Here's How You'll Want to Do It After the War —When You Can Buy NUGGETS!


This picture shows you at work on the same tough 5/8" nut as in "A" above. But, now you're armed with NUGGET Socket Wrenches having a 7/16" drive.
MAN! THIS COMBINATION IS LIGHT AS A FEATHER BUT IT'S GOT THE GUTS TO STAND THE HEAVIEST PULL I CAN GIVE IT.
Ⓒ The Heavy Pull

Now — you shift over to that tight spot as in "B." It's a 5/8" nut but you don't shift to a handle and socket of a smaller series. You use the same 7/16" drive as in "C." NUGGETS are compact enough for these cramped quarters.
YES SIR! NUGGETS IN ONE DRIVE DO THE SAME WORK THAT ONCE MADE ME HAVE WRENCHES IN BOTH 3/8" AND 1/2" DRIVES
Ⓓ The Tight Spot

TAKE a look at your assortment of socket wrenches, *today!* Aren't many of the *socket sizes* the same in both the 1/2" and 3/8" drives?

And your handle types—ratchets, speeders, extensions—are also duplicated!

How would you like to own Socket Wrenches in *One* DOUBLE-DUTY DRIVE which makes it unnecessary to keep both 3/8" and 1/2"?

Well, you can have such miracle wrenches—after the war when Blackhawk will make NUGGETS again. Don't buy old-fashioned wrenches unless you absolutely need them. Wait for NUGGETS! They're *worth* waiting for! Ask any mechanic who owns a set of NUGGETS!

A Product of **BLACKHAWK MFG. COMPANY,** Dept. W125, Milwaukee 1, Wisconsin

TO PRESENT NUGGET OWNERS: If you have lost any of your 7/16" drive wrenches, see your Blackhawk Jobber. He will arrange delivery of the replacements. Blackhawk wishes to protect the investment of present owners, even though Nuggets cannot be made and sold on a mass scale to new buyers until after the war.

BLACKHAWK NUGGET SOCKET WRENCHES

THE WRENCHES THAT SMASHED TRADITION

7/16" DRIVE WRENCHES 3/8" DRIVE WRENCHES 1/2" DRIVE WRENCHES

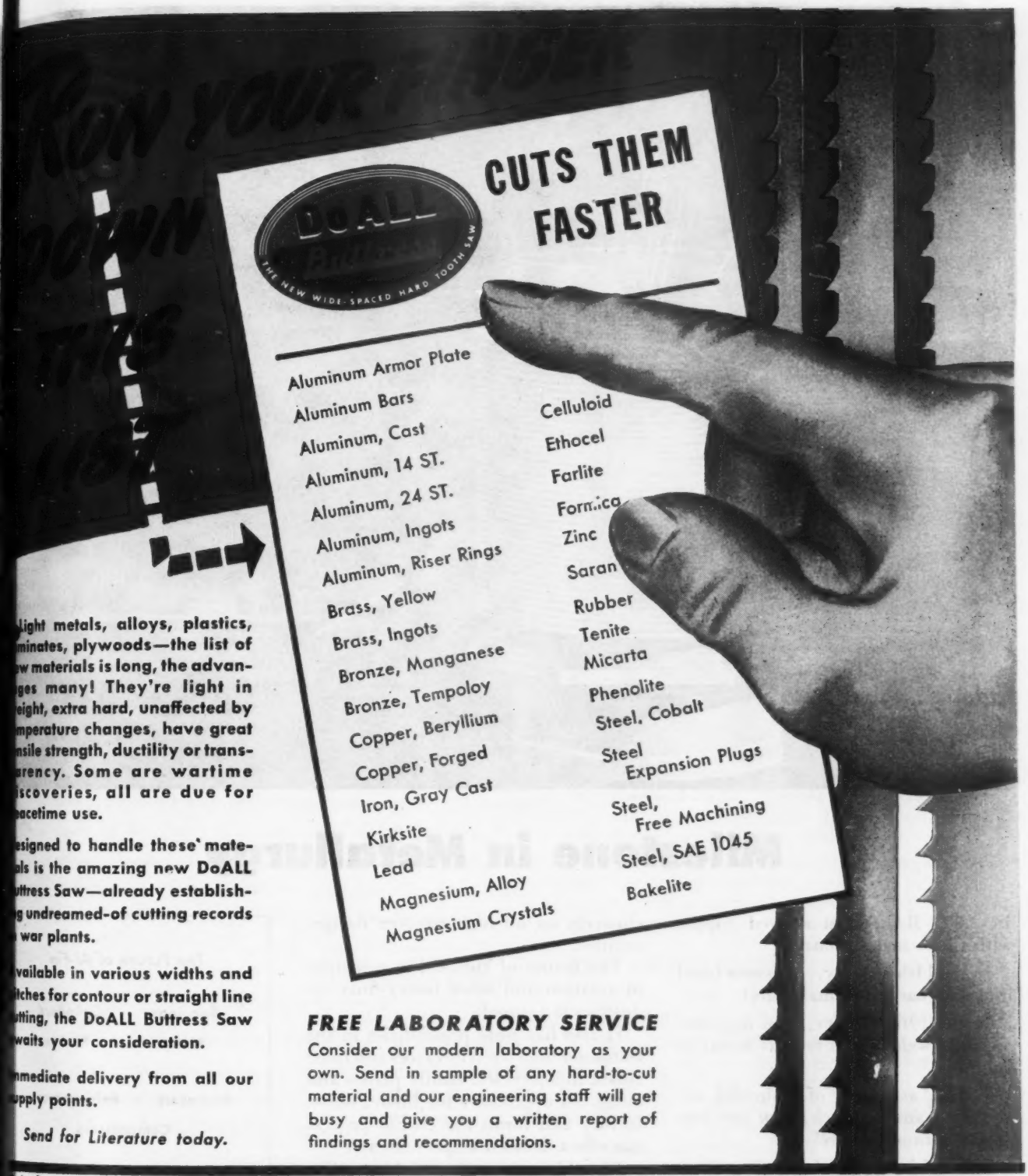
Don't Buy Two Sets When One Will Do the Job!

Engineering Vision . . . Manufacturing Precision

In ships at sea, in fighter and bomber planes, at command posts and in tanks and vehicles . . . Delco Radio products are carrying out vital assignments for the fighting forces. They represent the application of radio and electronic science to varied requirements of communication, detection and protection. They represent, too, the effective combination of engineering vision and manufacturing precision that safeguards the performance of all Delco Radio equipment, wherever it serves and whatever its purpose. Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

Delco Radio
DIVISION OF
GENERAL MOTORS

Make Your Dollars Fight
BUY MORE WAR BONDS



Light metals, alloys, plastics, laminates, plywoods—the list of new materials is long, the advantages many! They're light in weight, extra hard, unaffected by temperature changes, have great tensile strength, ductility or transparency. Some are wartime discoveries, all are due for peacetime use.

Designed to handle these materials is the amazing new DoALL Buttress Saw—already establishing undreamed-of cutting records in war plants.

Available in various widths and pitches for contour or straight line cutting, the DoALL Buttress Saw awaits your consideration.

Immediate delivery from all our supply points.

Send for Literature today.

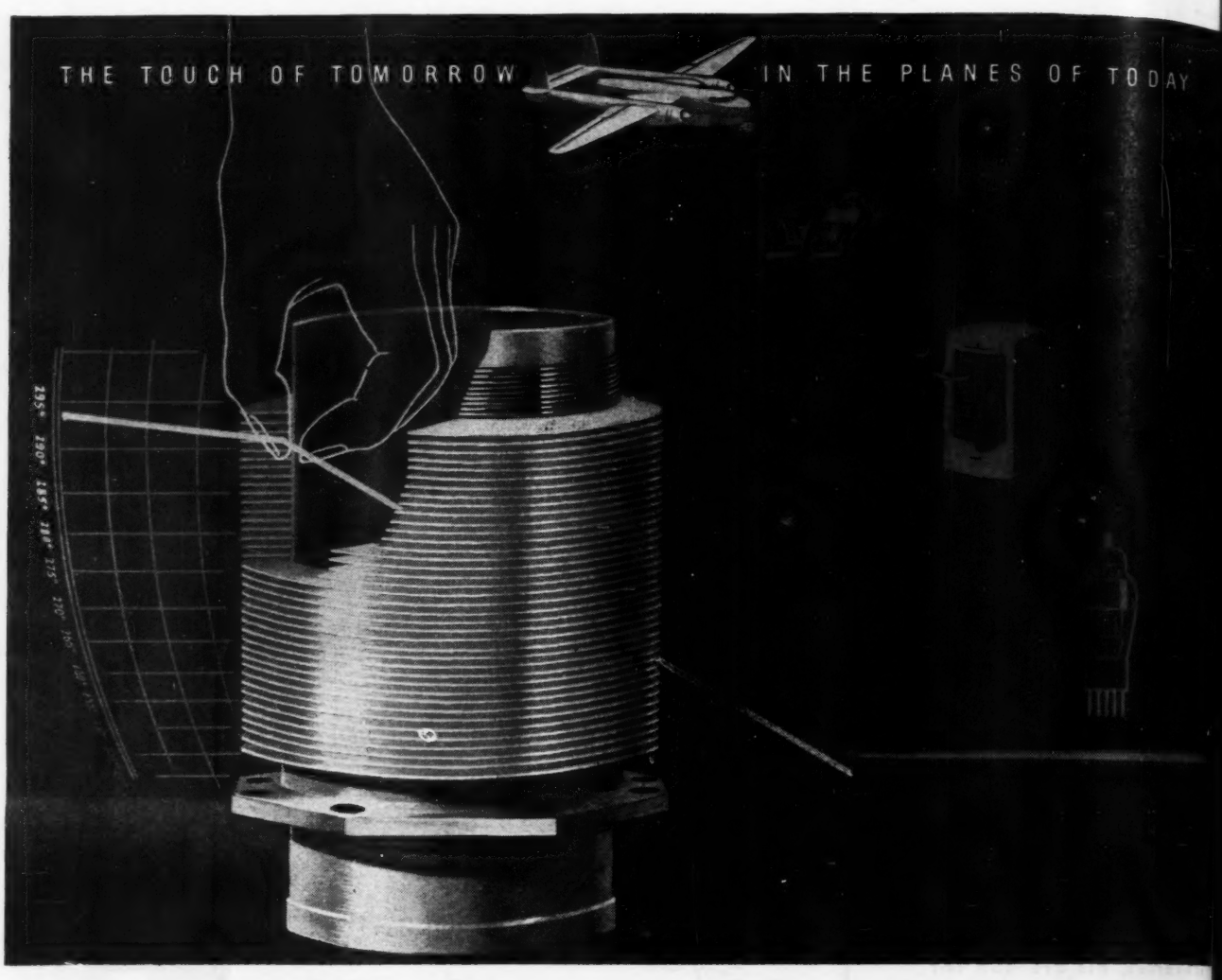
FREE LABORATORY SERVICE

Consider our modern laboratory as your own. Send in sample of any hard-to-cut material and our engineering staff will get busy and give you a written report of findings and recommendations.

DoALL

THE DoALL COMPANY

203 N. Laurel Ave. Des Plaines, Ill.



Milestone in Metallurgy

In 2,000 B.C., man alloyed copper with tin to make bronze.

In the 14th century, craftsmen fused iron with carbon to make steel.

In the 19th century, man first successfully welded one ferrous metal to another.

Today, as result of Fairchild engineering and research, *man can now join aluminum to steel!*

Through its application to aircraft engines—the chemical bonding of aluminum to cylinder barrels—Fairchild engineers have been able to achieve far more rapid dissipation of heat—greater development of horsepower without increasing piston displacement. The A1-Fin cylinder is being used exclusively on all higher-power Ranger engines.

The future of the Al-Fin principle in aviation and other heavy-duty industries is assured.

It also has wide possibilities in the consumer field—refrigerators and radio tubes, motorcycles, family planes and autos. In appliances for home, office, factory and farm, the Al-Fin process can effect decided improvements.

Listed here are a few of the possible additional applications of the Al-Fin Process.

As you consider their magnitude consider what makes them possible—the research and engineering of an organization whose credo is "The Touch of Tomorrow in the Planes of Today."

The Future of Al-Fin

Bearings • Cylinders
Pistons • Brakes

Radiators • Refrigerators
Compressors

Fire pumps • Motorcycles
Auxiliary power plants

and many others

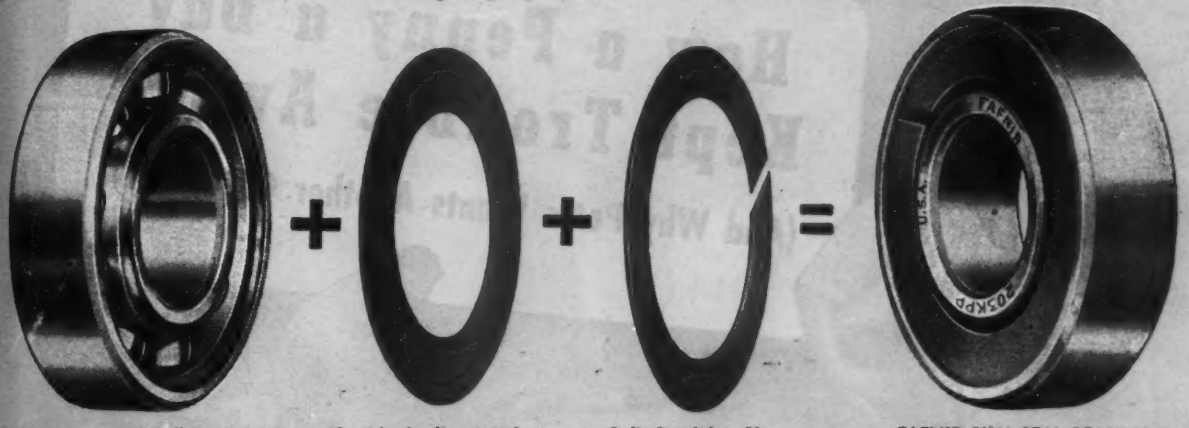
BUY U.S. WAR BONDS AND STAMPS

RANGER AIRCRAFT ENGINES

Division of Fairchild Engine and Airplane Corporation • Farmingdale, Long Island

FAFNIR PLYA-SEAL BALL BEARINGS

Performance Proved in Military Equipment • Now Available for General Use



Fafnir Standard Ball Bearing. Flexible Sealing Washer Split Retaining Ring FAFNIR PLYA-SEAL BEARING

POSITIVELY SEALED
—SEALS EASILY REMOVED

THE result of five years of development and testing, PLYA-SEAL bearings have proved the most effective, self-protected bearings yet designed. Approved for aircraft by the Army Air Forces and the Bureau of Aeronautics U. S. Navy, Fafnir PLYA-SEALS have been in use successfully for over two and one-half years in aircraft control bearings and operating equipment. Several thousand bearings incorporating the double PLYA-SEAL have completely eliminated former difficulties with metal shielded bearings in textile machines.

Whether you are designing a new product or planning to resume production on an old one, you will find it very much worthwhile to investigate and test Fafnir PLYA-SEAL Bearings. Write for complete descriptive folder. The Fafnir Bearing Company, New Britain, Conn.

WHAT IS PLYA-SEAL?

A diaphragm-type, contact seal comprised of two members – a flat, flexible sealing washer of synthetic rubber impregnated fabric and a split retaining ring of stainless steel.

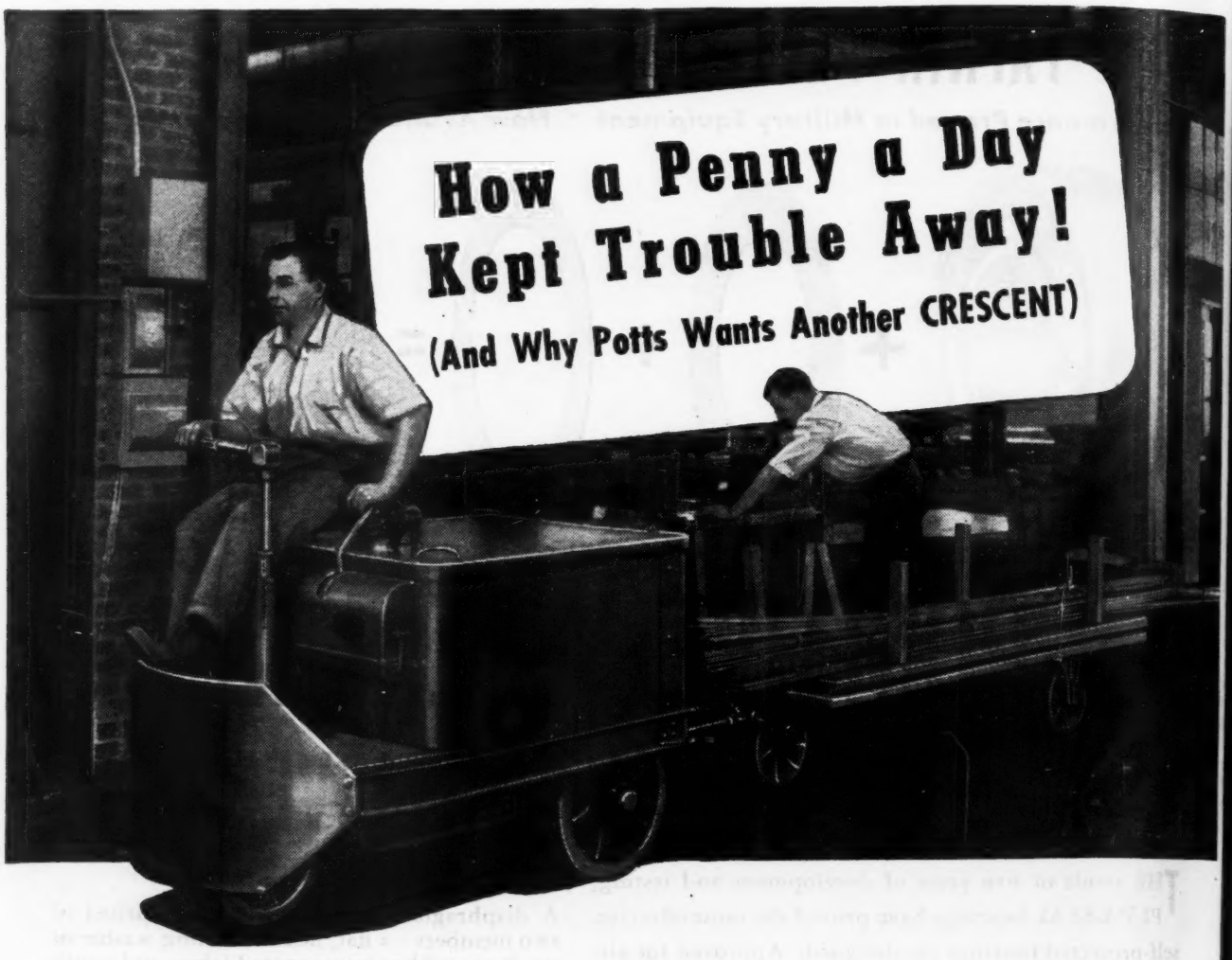
Firmly held in the outer ring, the sealing washer does not rotate with the inner ring but is in contact with a ground groove to form a very effective seal with a minimum of friction.

WHAT ARE PLYA-SEAL'S ADVANTAGES?

1. Assures maximum retention of lubricant, maximum exclusion of dirt and liquids.
2. Causes no distortion of the outer ring or race, nor does it affect the concentricity of either the rings or races.
3. Forms a positive seal with the outer ring while maintaining perfect contact with the inner ring.
4. Non-capillary and impervious to liquids, grease, oil, gasoline, water and a wide variety of solvents. Not affected by heat or cold. Sealing washer does not deteriorate with age.
5. Easily removed and replaced to allow inspection, washing and re-greasing.

PLYA-SEAL takes its place among these other FAFNIR "FIRSTS" . . . Wide Inner Ring Ball Bearing with Self-Locking Collar; Seal and Shield Type Bearings; Compact Super-Precision Spindle Bearings; Compact Super-position Retainers, Aircraft Ball Bearings, Rubber Pillow Blocks . . . and more.

FAFNIR
BALL BEARINGS



How a Penny a Day Kept Trouble Away!

(And Why Potts Wants Another CRESCENT)

TWENTY-TWO YEARS AGO, the Horace T. Potts Company, Philadelphia, purchased this Crescent Electric Tractor and has used it steadily ever since. That's a lot of service and, ordinarily, it would mean a lot of tractor parts replacement. But this was a CRESCENT *Electric* Tractor!

Total tractor parts replacement bill for the entire twenty-two years was only $86.90 — about a penny a day!

That's a phenomenal record for any type of mobile equipment. Because of that record, Potts has just purchased a new NTW Crescent *Electric* Tractor. It's this kind of service that explains why customers *continue* to buy Crescent Electric Trucks and Tractors.

Total Accessories Costs for 22 Years

Battery and tire replacements are, of course, beyond control of the tractor manufacturer except for the initial equipment. Yet smooth Crescent performance even provided Potts with a big saving on these accessories. Average total battery and tire costs for the twenty-two years were as follows:

2 Batteries	$800.63
3 Sets of Tires	136.60
TOTAL, 22 years . .	937.23
Cost per year	$ 42.60

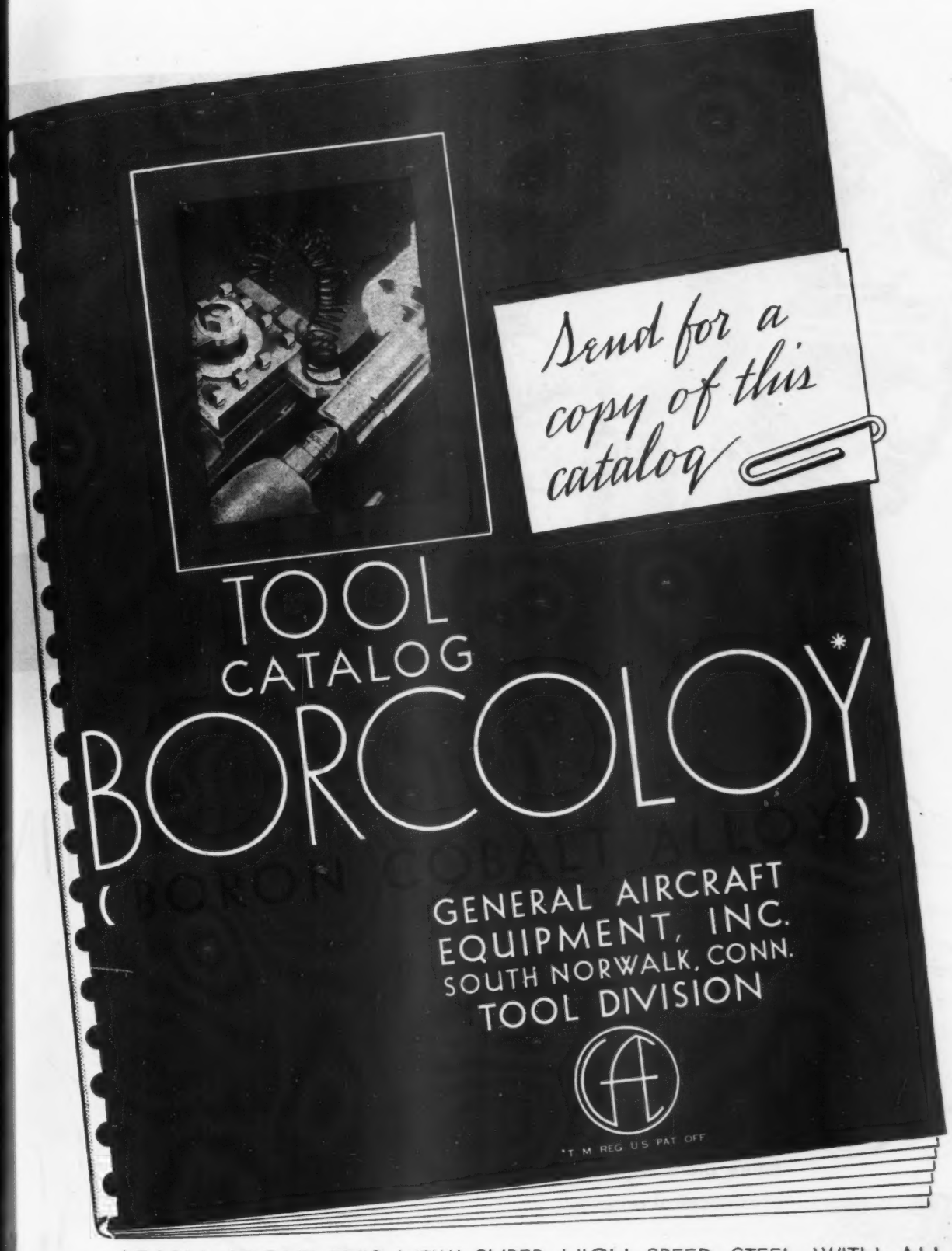
Total costs per day for tractor parts, batteries and tires averaged less than 13c.

The Modern Crescent NTW Twin Front Wheel Tractor. Designed to furnish low-cost, trouble-free, tractive power. Easy to handle. Twin steering wheel construction permits operation where congested areas and narrow aisles demand utmost flexibility. **Send for bulletin.**

CRESCENT TRUCK COMPANY 1120 Willow St., Lebanon, Pa.

Crescent ELECTRIC TRUCKS AND TRACTORS

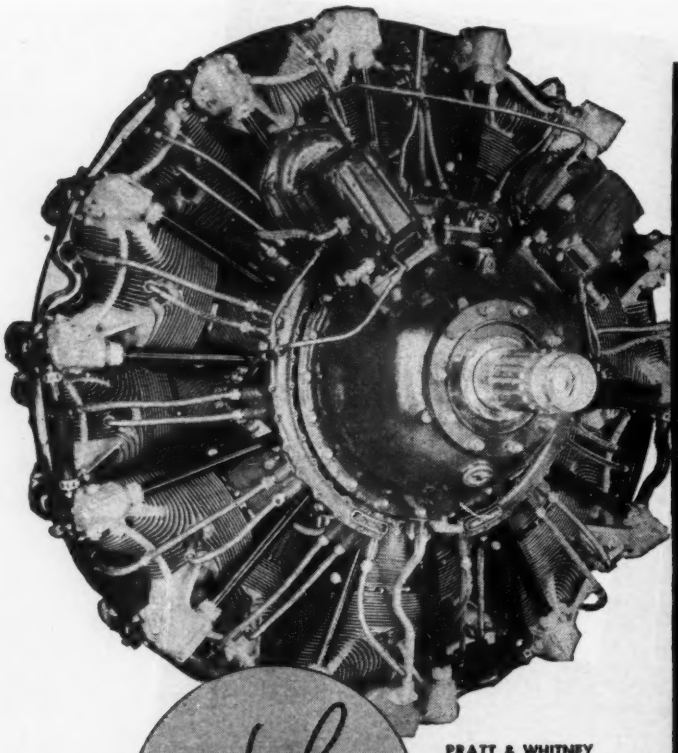
Industrial Truck and Tractor Specialists Since 1917



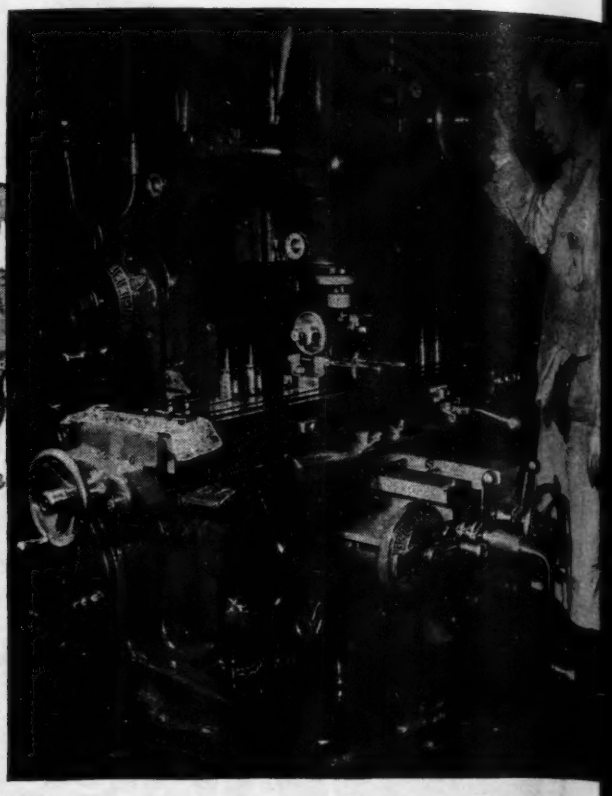
• LEARN ABOUT THIS NEW SUPER HIGH SPEED STEEL WITH ALL THE DISTINCTIVE FEATURES OF CENTRIFUGALLY CAST ALLOYS, WITH HIGH WEAR RESISTANCE DUE TO THE PRESENCE OF BORON AND WITH MAXIMUM RED HARDNESS IMPARTED BY TWENTY PER CENT COBALT •

GENERAL AIRCRAFT EQUIPMENT, INC.

SOUTH NORWALK, CONNECTICUT • TOOL DIVISION



PRATT & WHITNEY
TWIN WASP
ENGINE



PRECISION Lawson

ALL OVER THE WORLD ••

IT'S LAWSON PRECISION

● Power! — Titanic power! dependable, durable! That's the Pratt & Whitney "Twin Wasp"! What makes this power dependable and durable? The answer — quality precision machining of the maze of intricate parts.

● Lawson is proud to have been selected by the famous Pratt & Whitney Aircraft Division to manufacture vital parts for these engines. Lawson is ready and able to work with you on future plans that require close tolerances — the stepping-stones of mechanical progress.

Chester M. Lawson
President

SYMBOL OF PRECISION

LAWSON MACHINE AND TOOL COMPANY

120 MOUNTAIN AVE. 3, MALDEN, MASS.

Improved AVIATION FITTINGS

In addition to a complete line of fittings, Weatherhead makes valves, industrial hose, hydraulic cylinders and other parts for these industries:

AUTOMOTIVE
★
REFRIGERATION
★
RAILROAD
★
MARINE
★
FARM EQUIPMENT
★
ROAD MACHINERY
★
DIESEL
★
L. P. GAS
★
APPLIANCE MANUFACTURERS

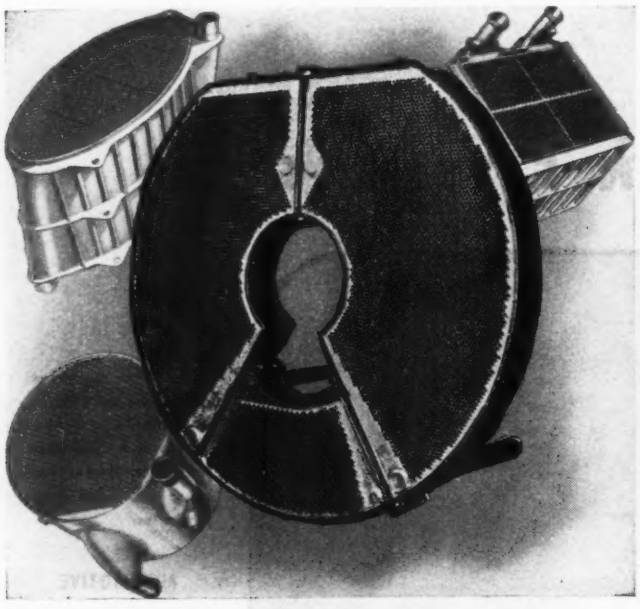
Look Ahead with

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND 8, OHIO
Plants: Cleveland, Columbia City, Ind., Los Angeles
Canada — St. Thomas, Ontario

So tremendous have been the wartime productive capacities of the four Weatherhead plants that we now have available for *immediate delivery* the greatest assortment of *improved* A-N Fittings of all types and sizes that we have ever been able to offer during our long experience in the aviation field. Take advantage of this situation by writing for our newest Surplus AN Stock Catalog today.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • DETROIT • CHICAGO • ST. LOUIS • LOS ANGELES



HOW ALUMINUM BRAZING SIMPLIFIES ODD SHAPES

Until recently heat transfer units have been complicated by special reinforcements to give them strength in unusual shapes. At high temperatures the soft solder, which bonds copper tubes to their shells and to each other, could not stand the severe stresses set up by pressure, vibration and shear in *unusual* shapes, unless other weight-increasing supports were added.

ALUMINUM BRAZING CHANGED ALL THAT

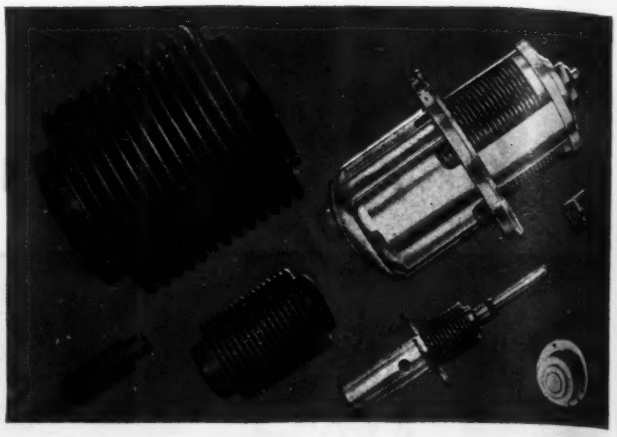
Discovery of a way to braze thin-walled aluminum tubes to aluminum header plates and shells made simply constructed odd shapes possible, for three reasons:

1. Aluminum alloy bonding material defies temperatures, pressures and strains several times higher than soft solder can stand.
2. Heat-treatable aluminum alloy tubes, header plates and shells stand temperatures and pressures that cause copper to anneal and weaken.
3. Aluminum's weight being ⅓ that of copper affords other obvious advantages to designers of products incorporating heat transfer units.

That's why USAAF designers were quick to take advantage of Clifford's discovery and put Feather-Weights to use in a number of their aircraft models.

POSTWAR PLANNING

Now war orders occupy 100% of Clifford's production . . . but inquiries and suggestions about postwar applications of all-aluminum heat-transfer units to automotive, heating, cooling and ventilating fields are welcomed. *Clifford Feather-Weights . . . Save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 562 E. First Street, Boston 27, Mass.



IN HYDRAULICALLY-FORMED BELLOWS

the metal has to be right

Metallic bellows can be made four ways:

1. Built up from a number of sections.
2. Mechanically spun from a welded tube.
3. Mechanically spun from a seamless tube.
4. Hydraulically formed from a seamless tube.

The first and second are as strong as their metal and joints; the third as its tool-scratched metal; the fourth as its metal only.

In hydraulically forming a bellows, no spinning tool touches its surface. It's made by forming the paper-thin walls of a metal tube between the plates of a collapsible die by means of internal hydraulic pressure. And since that pressure is much higher than any pressures it will meet in service, any bellows that survive the forming process must be metallurgically sound.

Therefore, to make hydraulic forming practical the metal from which the tube is made must be free from slag and scale inclusions . . . and the tube must be free from draw die marks, variations in wall thickness and faulty crystalline structure.

Clifford, being the first to produce hydraulically-formed bellows for industry, not only realizes the importance of metal selection, but also appreciates the critical nature of all processes involved in making bellows assemblies for controlling temperature and pressure; for sealing against pressure leakage; or for other exacting uses. *First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Co., 561 E. First Street, Boston 27, Massachusetts.

CLIFFORD *Feather-Weight* **OIL COOLERS AND COOLANT RADIATORS**

HYDRAULICALLY-FORMED BELLOWS HYDRON

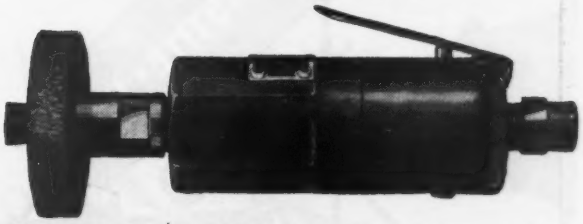
FASTER FINISHING WITH CLECO LIGHT GRINDERS

● For finishing forgings, dies, metal patterns, castings and similar work, you can't beat Cleco Light Grinders. They are light in weight, small and easily handled, yet pack plenty of power. The No. 214 series of Cleco Grinders is available at speeds of 14,000 and 18,000 R.P.M. and are governor controlled, while Model 12 is faster at 20,000 R.P.M. Fitted with ⅜", 24 S.A.E. thread spindles. Exhaust deflector included.

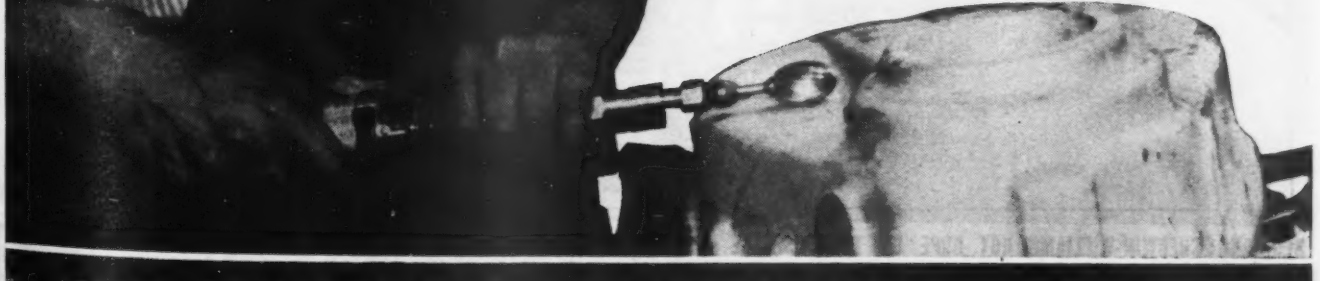
Standard equipment consists of spindle nut and washer, and ¼" collet chuck. Spindle extension 1½" or 3" long furnished, in lieu of collet chuck, when specified. Dead handle supplied when so ordered.

Bulletin 80 describes these light grinders in detail, as well as furnishing complete data on the entire line of Cleco Rotary Grinders. Ask for it!

Working inside a casting.



Above, a Cleco 214J light grinder. Below, a Cleco No. 214 smoothing up an aluminum casting, with a rotary file.

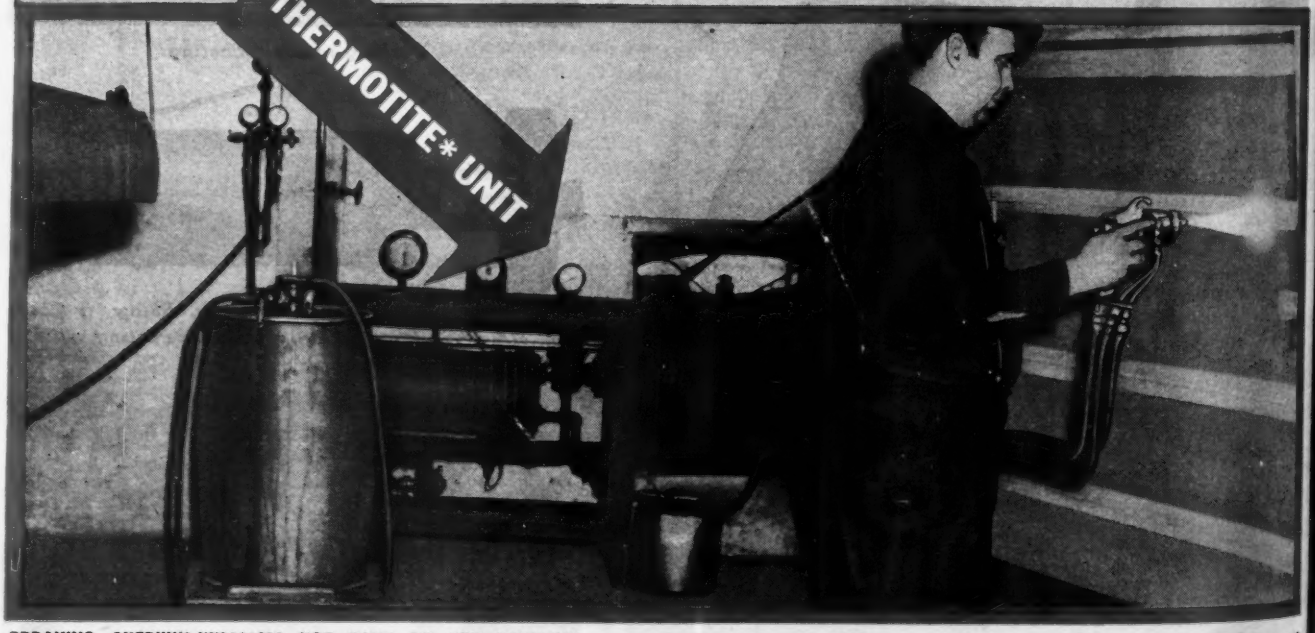


THE CLEVELAND PNEUMATIC TOOL CO.

3781 East 77th St. • Cleveland 5, Ohio *Branch Offices in All Principal Cities*

MAKING GLIDER PRODUCTION SOAR!

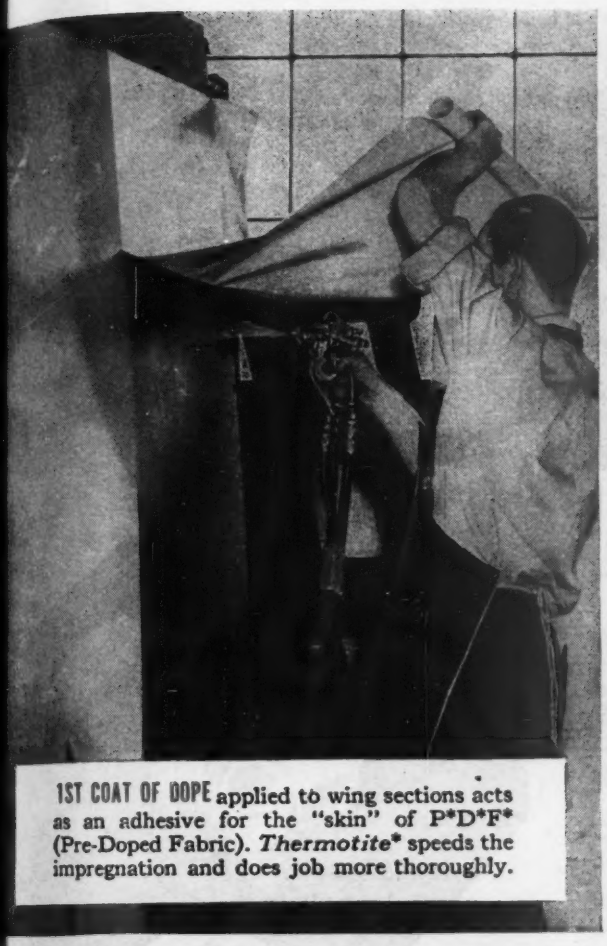
WINGS FOR 16 FLYING DOUGHBOYS! A new CG-15-A troop-carrying glider being towed away from Waco Aircraft's Troy, Ohio, plant.



SPRAYING SHERWIN-WILLIAMS HOT DOPE ON THE FUSELAGE with the Sherwin-Williams perfected *Thermotite** machine.

Easy to use and simple to maintain, the *Thermotite** unit substantially cuts the number of doping coats required.

SHERWIN-WILLIAMS



1ST COAT OF DOPE applied to wing sections acts as an adhesive for the "skin" of P*D*F* (Pre-Doped Fabric). *Thermotite** speeds the impregnation and does job more thoroughly.

2ND AND FINAL COAT is cross-laid over the "skin" of the wing, completing the doping job and fully preparing it for coating with Sherwin-Williams Olive Drab—*Thermotite** applied!

THERMOTITE* PROCESS

lashes production time on new WACO troop-carrying glider!

Only two coats of dope required! Production early doubled! That's the big news to come t of Waco Aircraft's application of *Thermo-ite** in the manufacture of the new CG-15-A oop-carrying gliders!

On fuselage, tail and wing structures, tapes e applied with Sherwin-Williams cold dope er P*D*F* (Pre-Doped Fabric) and are llowed by a cross-coat of hot dope applied th the *Thermotite** unit. The doping job completed with a single coat of Sherwin-illiams Olive Drab fed through the *hermotite** machine. The body of the glider ready for assembly.

The wings, built of precisioned plywood, rst go through a sealing process. A coat of Sherwin-Williams hot dope is then *Thermotite**-applied... forms a perfect adhesive for the "skin" of Pre-Doped Fabric. A cross-coat of clear hot dope and a single application of Olive Drab follow.

Here's another example of how *Thermotite** eliminates need for thinners and effects revolutionary savings in time and labor. Want complete details? Just write today to The Sherwin-Williams Co., Cleveland 1, Ohio.

ermotite and P*D*F*—Trade-marks Reg. U. S. Pat. Off.

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Delco-Remy
Aircraft Electrical Equipment

With grease on his hands and hope in his heart, the man who gives a part of himself to every patch and repair "sweats out" his mission on the ground. He gets no glory, no battle honors. His reward is the sight of a plane returning safely, and the confidence of officers and crew in his skill. Delco-Remy electrical equipment is serving today in America's heavy and medium bombers, carrying out its part in a large assignment. More than half of Delco-Remy's facilities are engaged in the manufacture of electrical units, precision parts and products for the aircraft industry. When Victory is finally won, Delco-Remy equipment will help maintain the dependability of commercial aircraft and bring the convenience of dependable electric starting, lighting and ignition to light plane owners.

ARMY E NAVY

DELCO-REMY

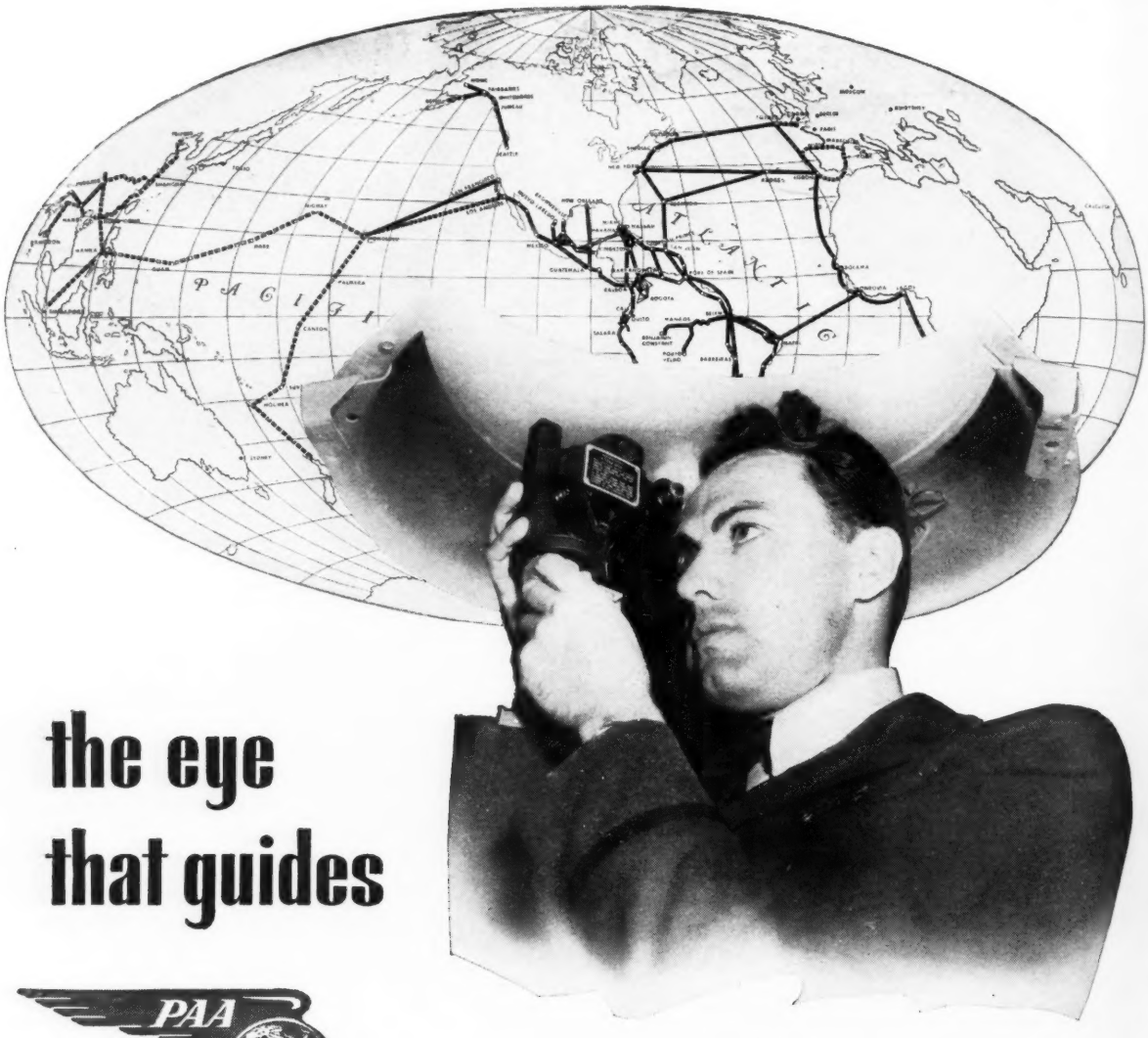
WAR BONDS WILL BRING THEM HOME SOONER

DIVISION, GENERAL MOTORS CORPORATIO

Bombers Roll and Fly

ON BOWER ROLLER BEARINGS—On the runway or in the air, Bower Roller Bearings carry the rolling load of the big Bombers—in the engine, in the controls, in the landing wheels and other locations. World War II is a war on bearings.

BOWER ROLLER BEARING
Detroit 14, Michigan



the eye that guides

PAA *wings over the world*

The global air routes pioneered by Pan American World Airways have proved to be of outstanding importance to our war.

When the Japs struck at Pearl Harbor, PAA routes were immediately available for the use of our Armed Forces. Today, as the war draws to a crisis, PAA flight crews are serving both the Army and Navy in flying personnel and materiel to every theatre of operations of our world-wide battlefronts.

And the PAA navigators, operating under the Miami based Air Transport Command, are safely basing their calculations on the readings of the Fairchild Aerial Sextant — a sextant that has the full confidence of men who know the skies.

And rightfully so. For Fairchild Aerial Sextants were developed from a basic design suggested by the U. S. Army Air Force to be compact, lightweight, easily handled... with a bubble that remains 'stable' . . . with automatic recording of consecutive sights during the entire sighting cycle of optional duration.

Fairchild leadership in the design and precision production of aerial operations instruments . . . which include aerial sextants, cameras, radio direction finders, lead computing gun sights . . . is the reward of an air-minded policy of engineering and building far beyond the stated basic specifications of any given problem. *New York Office:* 475 - 10th Ave., New York 18; *Plant:* 88-06 Van Wyck Blvd., Jamaica 1, New York.

FC

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AERIAL SEXTANTS

FORMATIONS FOR VICTORY

U. S. Army Air Corps Photo

LOOK at a perfect formation of fighter planes in the sky ... and you'll see the significance of a "formation" of drums on a beach head. Inside those drums is the fuel for victory in the air. And to guard that fuel — to keep it safe from seepage, dust and contamination — is the war-time job of Tri-Sure Closures.

The critical needs of war have proved repeatedly what every user of drums should know: if Tri-Sure Closures are on a drumhead, every drop inside that drum is safe. The reason is that Tri-Sure Closures seal a drum *hermetically* with a *seal*, *plug* and *flange* that no water or impurities can pass.

This is Tri-Sure's famous *triple protection* that enables drums to be stored in the open for months, or shipped thousands of miles, without leakage, seepage or loss. And that is the kind of protection that *every* drum in *every* shipment should have.

Tri-Sure
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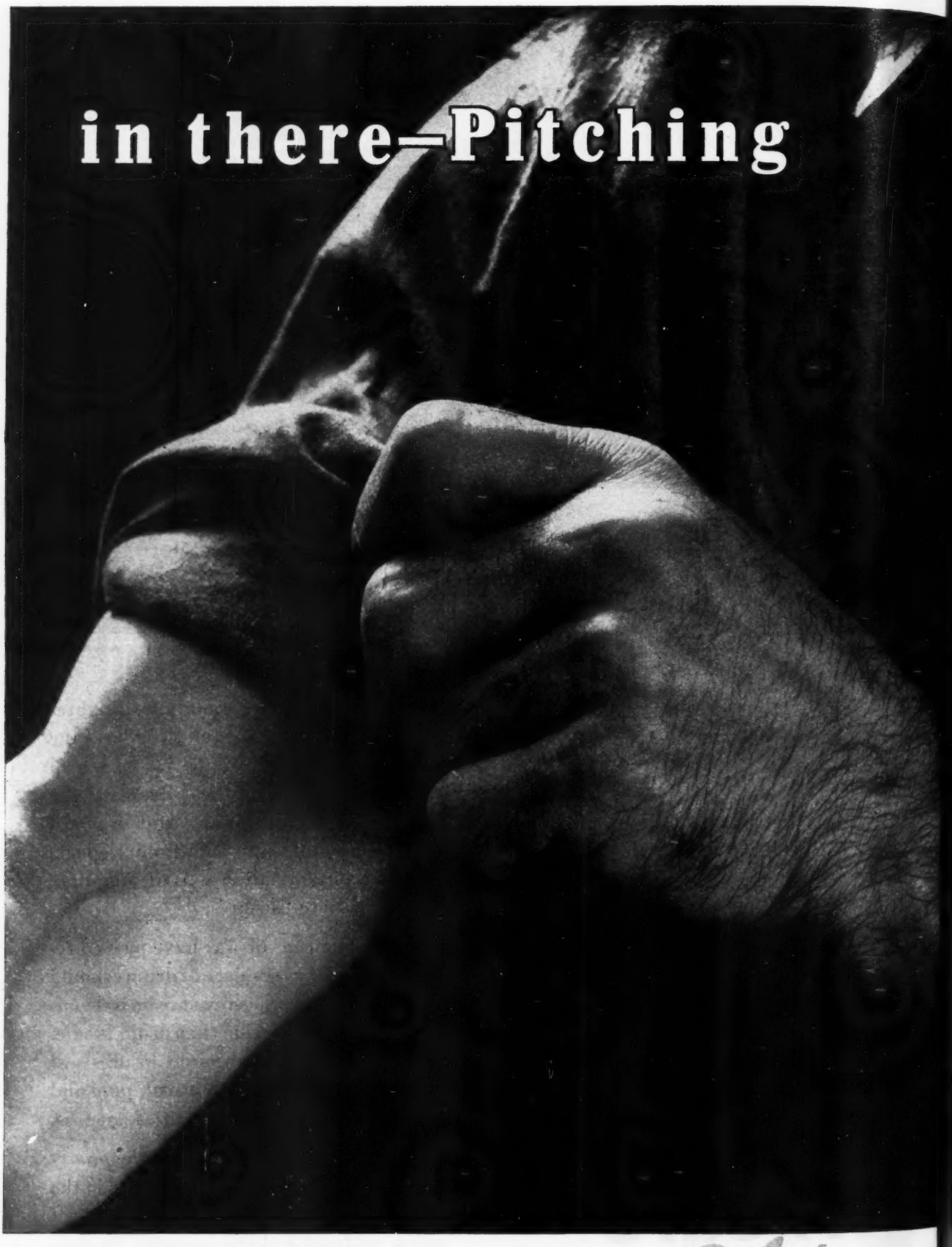
AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA



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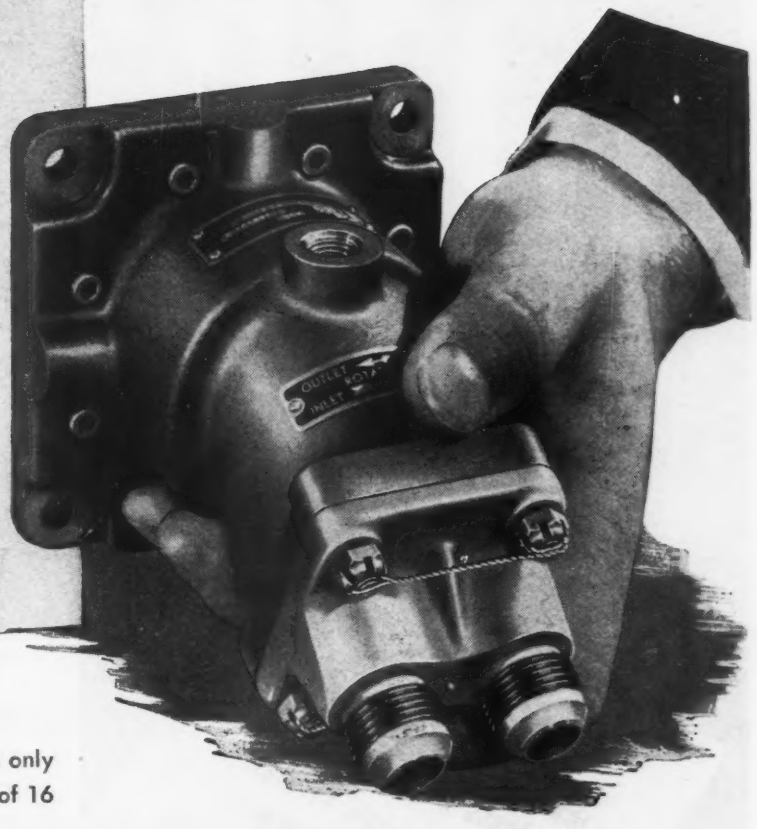
CHICAGO ENGINEERING OFFICE—600 SOUTH MICHIGAN AVENUE

2.5 HORSEPOWER PER POUND

IS THE OUTPUT OF THIS

VICKERS AIRCRAFT HYDRAULIC MOTOR

(PISTON TYPE CONSTANT DISPLACEMENT)



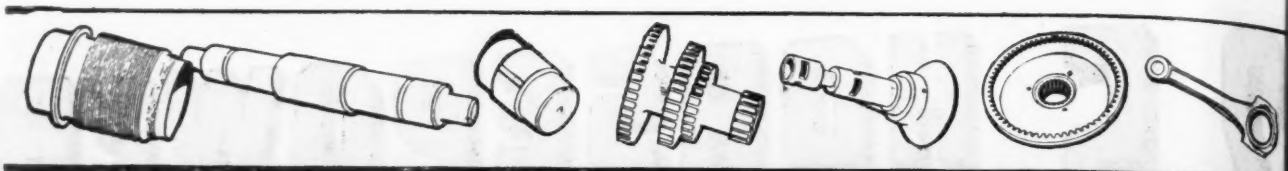
This Vickers Aircraft Hydraulic Motor weighs only 6.4 pounds yet it has a normal output rating of 16 horsepower at 3000 psi and 3750 rpm.

But a high horsepower/weight ratio is not the only advantage of using Vickers Hydraulic Motors for delivering rotary mechanical motion on many aircraft applications. These hydraulic motors save space as well as weight. Starting and stalled torque both closely approach operating torque. They can be stopped accurately to position. . . . No clutches or brakes are required. They are used for dynamic braking and can be stalled for long periods without damage. These hydraulic motors can be started and stopped instantly due to the very low inertia of the moving parts. They cause no radio interference. Reversal and accurate control of speed are very simply and easily accomplished.

Vickers Aircraft Piston Type Hydraulic Motors are inherently simple and rugged; they are available in a wide variety of models for operating pressures up to 3000 psi.

VICKERS *Incorporated* • **1462 OAKMAN BLVD.** • **DETROIT 32, MICHIGAN**

Engineers and Builders of Oil Hydraulic Equipment Since 1921



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PLATES • SHEETS • STRIP
in all commercial sizes

FOR PARTS . . .
• that must have high surface hardness and wear-resistance
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WE are in excellent position to furnish the complete line of special alloy steels most suitable for case hardening by nitriding.

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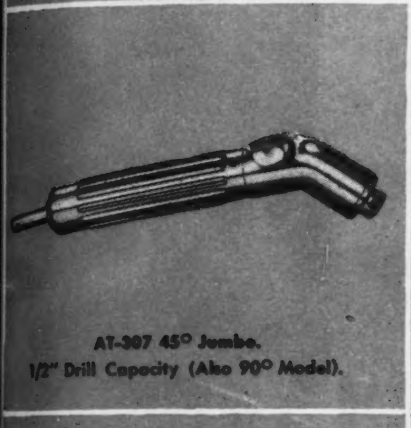
UNITED STATES STEEL

AT-322 90° Junior.
3/16" Drill Capacity (Also with Flex Drive).

AT-303 45° Flex Standard.
3/8" Drill Capacity (Also 90° Model).

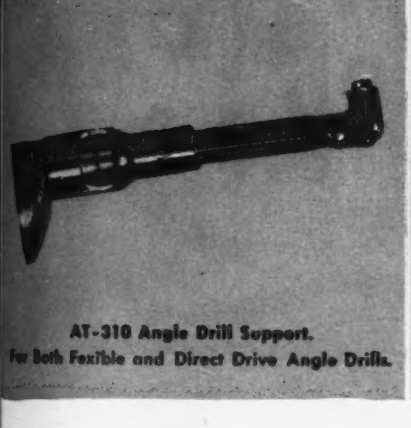
AT-300 90° Standard.
3/8" Drill Capacity (Also 45° Model).



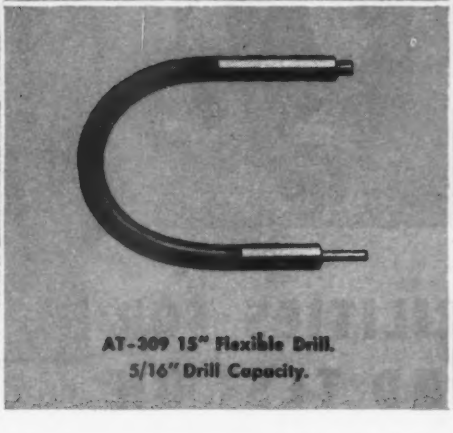
AT-307 45° Jumbo.
1/2" Drill Capacity (Also 90° Model).

AT-312 360° Flex.
3/8" Drill Capacity (Also Direct Drive Model).

AT-308 Pork Chop.
5/16" Drill Capacity.



AT-310 Angle Drill Support.
For Both Flexible and Direct Drive Angle Drills.



AT-309 15" Flexible Drill.
5/16" Drill Capacity.

AT-318 90° Helgun Attachment.
(Also 45° Helgun and 90° and 45° Thor).

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for Every Purpose!

Aircraft Tools Angle Drills and Flexible Shaft Drives are designed for aircraft fabrication and are ideal wherever power transmission in a hand tool is required. They are rugged—precision-built to give long, trouble-free service under the most exacting conditions. Full radial ball bearing construction throughout. Drive shafts and spindles are made of carefully ground heat-treated alloy tool steel. All angle drills and attachments are "broken in" and tested on a specially designed test stand before delivery.

Shown are only a few of the sizes and types available. For complete information, please write for new catalog.

Complete Repair Service for All Types of Aircraft Tools.

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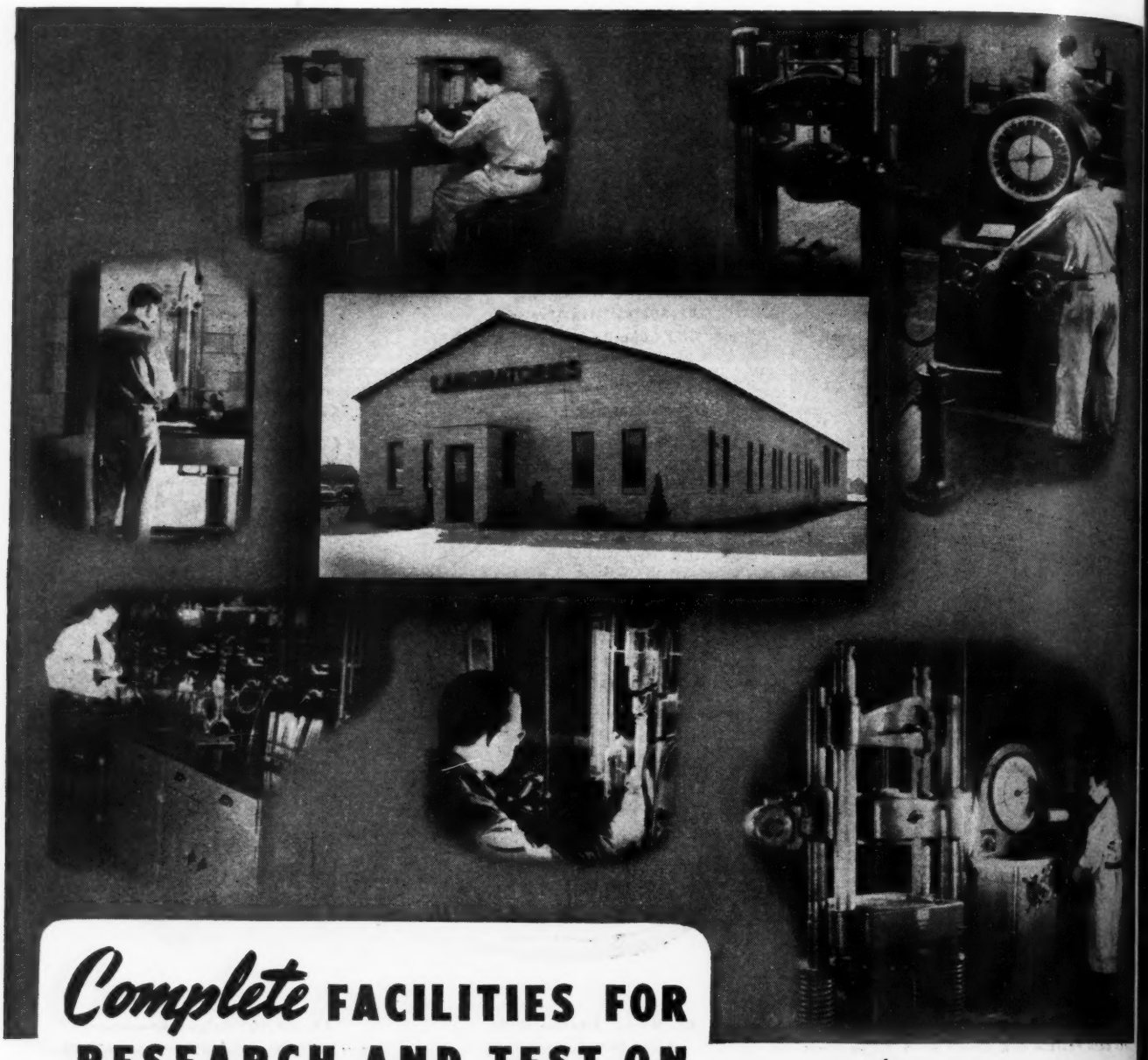

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Day in and day out, in a spacious building with complete and modern facilities, Globe chemists and metallurgists conduct research on tubing problems. Testing and inspection of Globe Steel Tubes are regular routine. Special problems of customers are studied, too, and physical and chemical tests, spectrographic and microscopic examinations are made, to select the correct analyses for each customer's particular needs. The Globe technical staff is available at the mill or in the field, for technical service on tubing problems.

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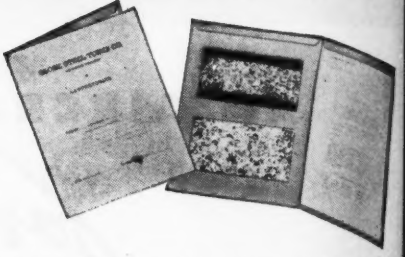

A typical special report, prepared by the Globe laboratory and technical staff.

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★ Boiler and Pressure Tubes
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WITH A

Lamb Electric MOTOR

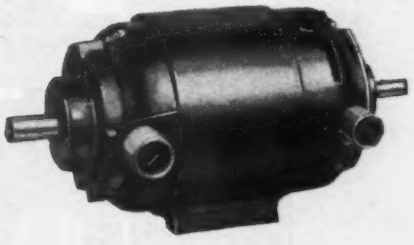
30 years' experience designing and building fractional horsepower motors for all types of special applications has taught us where and how much *motor* weight can be reduced without interfering with essential electrical characteristics. Our knowledge of products gained by close cooperation with many types of manufacturers frequently enables us to make design suggestions that reduce *product* weight as well as improve compactness. It is best to discuss the motor while your products are in the *early stages* of development.

THE LAMB ELECTRIC COMPANY
KENT, OHIO

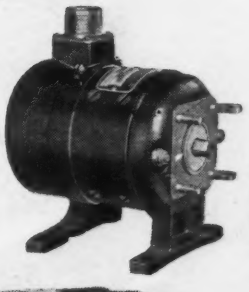
THOROUGH ENGINEERING

Is the basic factor behind the successful operation of the special application motors shown here and many others we have designed and built for all types of equipment.

D. C. Motor with A. C. take-off, especially developed for a portable aircraft engine heater.

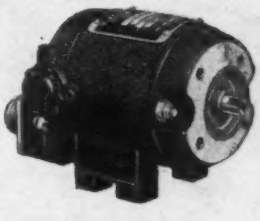


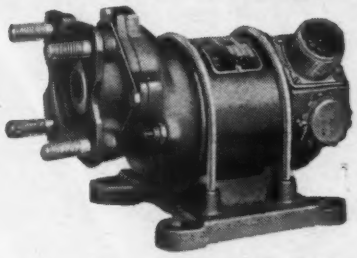
Intermittent high torque motor with low weight factor, developed for aircraft service.



Small, sturdy motor especially designed for aircraft heater service but can be readily adapted to a wide range of industrial applications.

Compactly designed motor developed for de-icer metering pump and special instrument service.





Base-mounted, explosion-proof aircraft geared fuel transfer pump motor. Precision built with compactness and dependability.

Lamb Electric

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SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

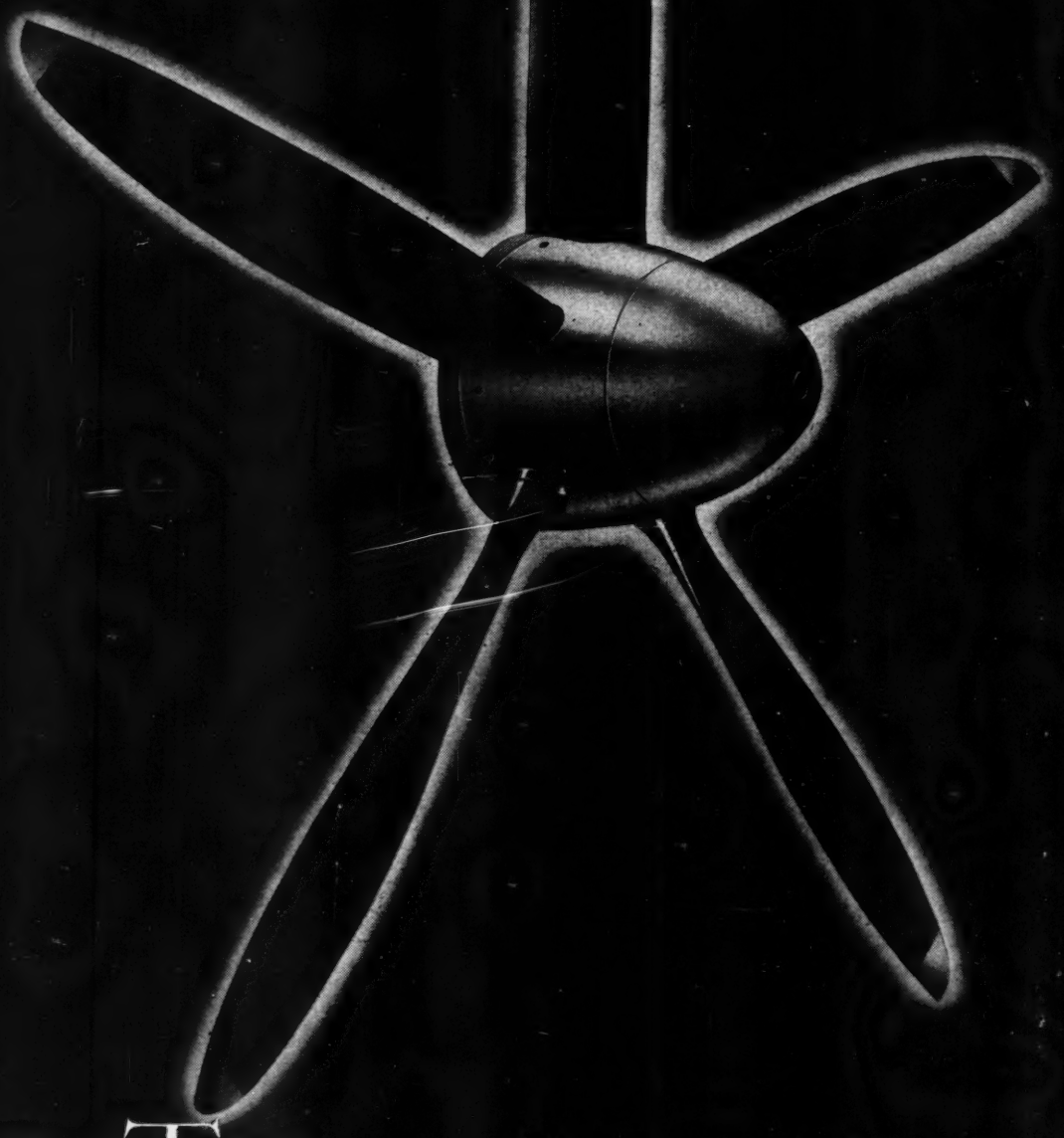
Fitted to

ONE OF BRITAIN'S FOREMOST FIGHTERS

5-BLADE

'CONSTANT SPEED'

VARIABLE PITCH PROPELLER



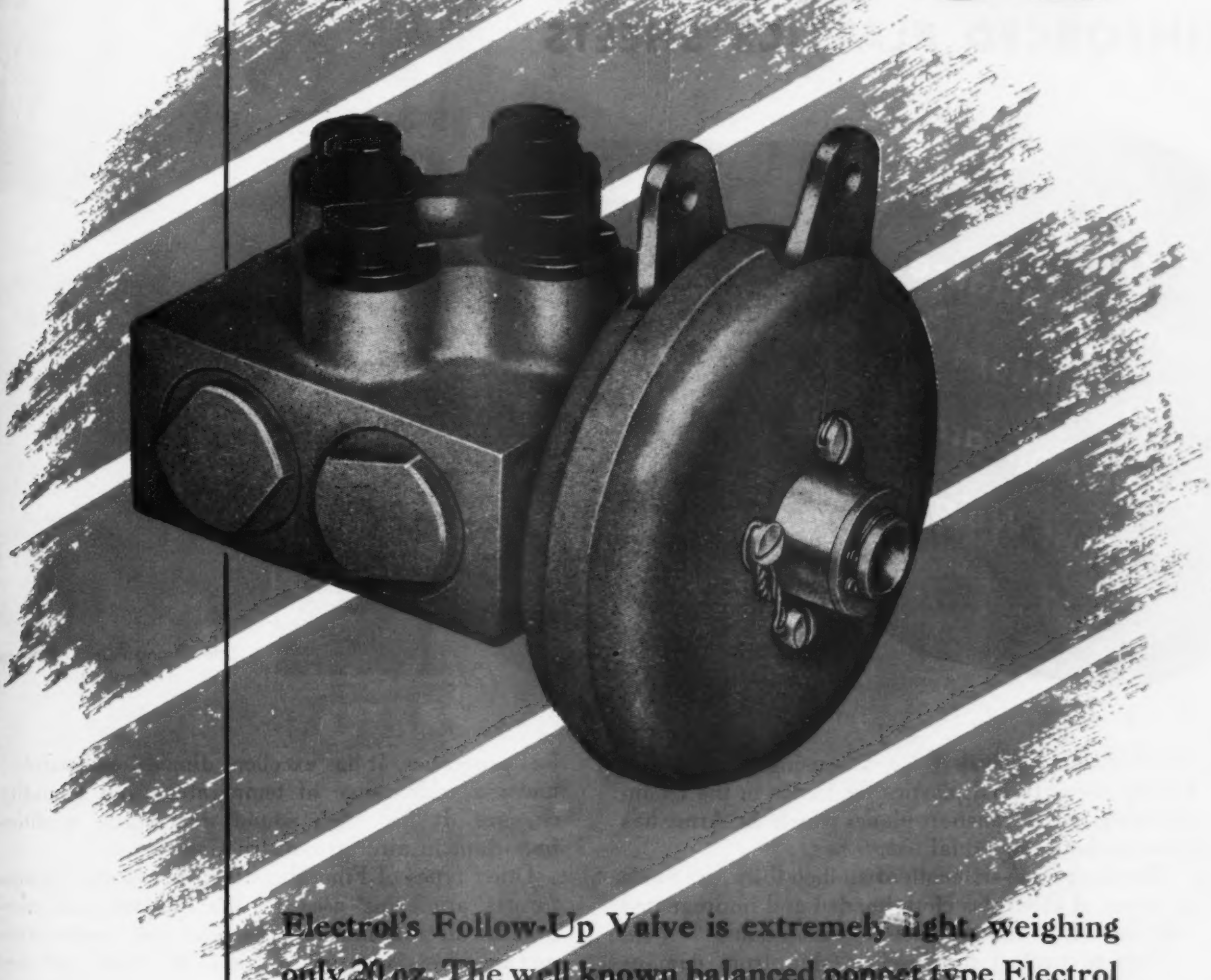
ROTOL

LIMITED, ENGLAND.

Designers and Manufacturers of

ALL-BRITISH 'CONSTANT SPEED' VARIABLE PITCH PROPELLERS

control



Electrol's Follow-Up Valve is extremely light, weighing only 20 oz. The well known balanced poppet type Electrol Selector Valve mechanism assures dependability.

ELECTROL'S FOLLOW-UP VALVE

Originally designed for Wing Flap installation, it is equally valuable to such other uses as carburetor, rudder or any service where smooth, accurate and complete control is required.

Electrol engineers will welcome an opportunity to design a Follow-Up Valve installation for any service in aircraft or general industrial application.

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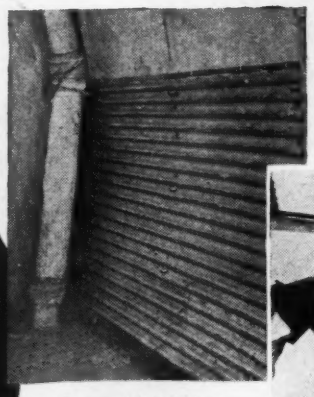
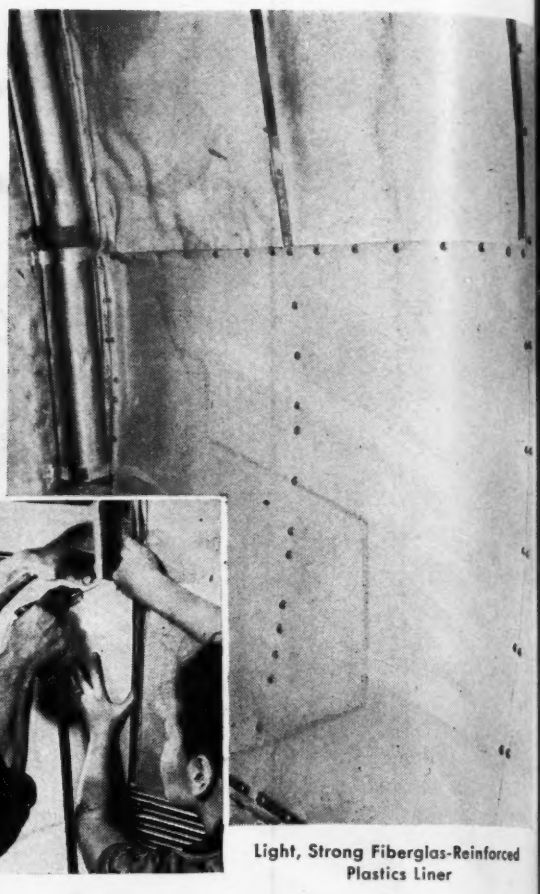
REINFORCED PLASTICS SHEETS

—Gives
Greater Resistance to puncture
Better Appearance
Light Weight



Former Metal Liner



Light, Strong Fiberglas-Reinforced Plastics Liner

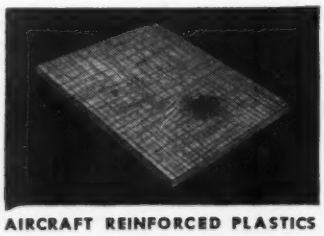
Pennsylvania Central Airlines is using thin, strong, Fiberglas-reinforced plastics laminates in the reconditioning of the transport planes which the Army has released for commercial use.

The sheets, one-sixteenth of an inch thick, are made of layers of Fiberglas cloth bonded and impregnated with one of the new contact-pressure resins.

Used to protect the fuselage skin from damage which might result from the loading and unloading of heavy cargo items, this material has greater impact strength and is lighter in weight than the corrugated metal formerly installed. The combination of Fiberglas and certain types of resins, results in a material having many unique physical and mechanical properties. It has excellent dimensional stability under a wide range of temperature and humidity changes. It has high sound dampening qualities important in aircraft construction.

Other types of Fiberglas (fibrous glass in various forms) are being used by the military and commercial aircraft industry for both new construction and reconversion work. A few of the types and uses are listed below.

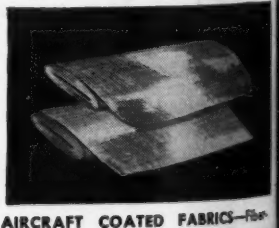
If you do not have complete data on Fiberglas in all of its various forms, or if you have a problem which Fiberglas may help solve, write *Owens-Corning Fiberglas Corp., 1891 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*



AIRCRAFT REINFORCED PLASTICS PARTS—fabricators are combining certain low-pressure resins with Fiberglas fabrics. Lightweight, impact strength, sound dampening. Used for panels and formed parts.

AIRCRAFT BLANKETS—for thermal insulation. Fireproof. Lightweight. Made of Fiberglas insulating wool, faced with Fiberglas cloth and sewn with Fiberglas thread.

AIRCRAFT TAPES—another all-glass product, woven from Fiberglas yarns. Incombustible. Used for insulating motors, generators, etc., and for lagging of thermal insulation on ducts and pipes.



AIRCRAFT COATED FABRICS—Fiberglas cloth used as a base for rubber, vinyl compounds and other coatings. Dimensional stability, high strength, humidity resistance. Used in flexible connections, etc.

FIBERGLAS

*T. M. Reg. U. S. Pat. Off.

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GRINDING WHEELS AND MOUNTED WHEELS

Chicago Wheel takes pride in providing you with exactly the wheel you need, for exactly the job you have, to give you exactly the finish you want!

There's half a century of experience behind this, fifty years of specializing on grinding wheels—grinding wheels with hundreds of varieties in shape, size, abrasive and bond formulas, engineered for the right tool speed and work pressure.

Come to Headquarters—Our long experience and testing laboratory are at your service, free for the asking. Tell us about your tough grinding or polishing job. Our abrasive engineers will report promptly, give you their tested solution.

TRY ONE FREE—A Chicago Mounted Wheel or an FV Bond Grinding Wheel sent promptly on request. Tell us size preferred and what you have to grind.

CHICAGO GRINDING WHEELS—For the duration, sizes up to 3" in diameter only, in various bonds including FV, the bond with a pedigree.

CHICAGO MOUNTED WHEELS—For internal or external grinding, burring and polishing. Made to fit any tool. Many styles, shapes and shank sizes.

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Send catalog. Interested in

☐ Mounted Wheels
☐ Grinding Wheels
☐ Send test wheel

Size _____

Name _____

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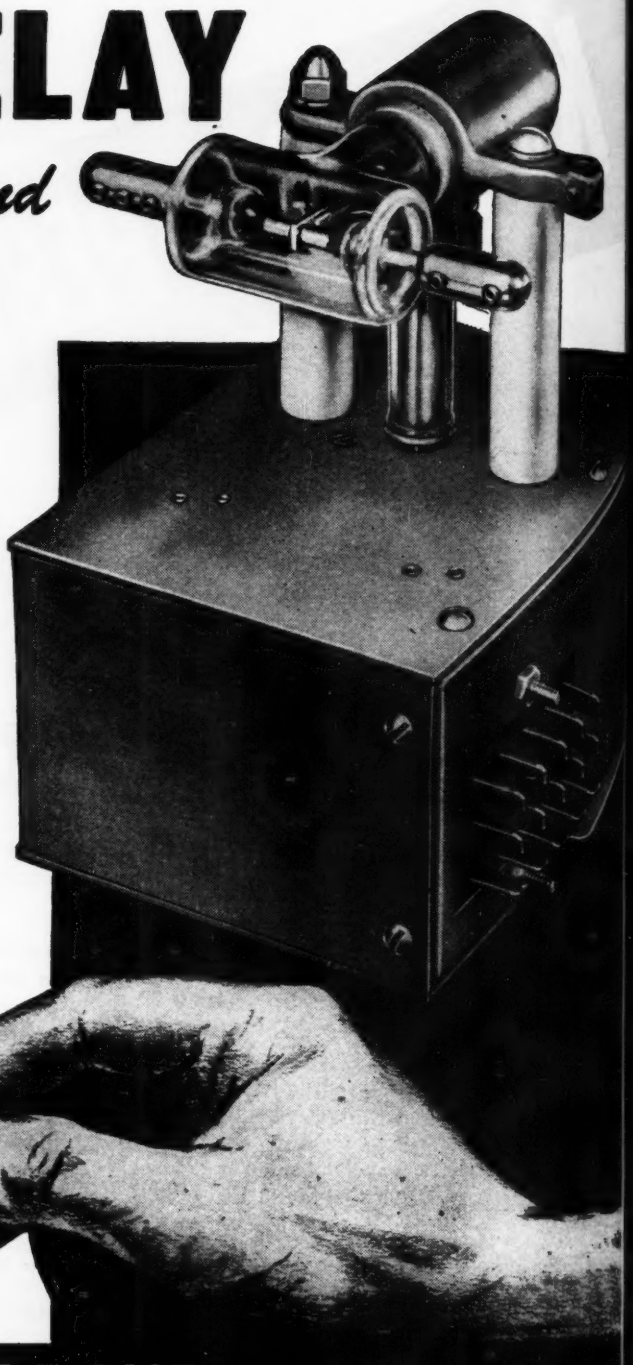
Half a century of specialization has established our reputation as the Small Wheel People of the Abrasive industry.

A New Vacuum Switch

KEYING RELAY

. . . . for Aircraft and Other Applications



Here is convincing proof that a keying relay does not have to be complicated to be efficient. In fact, just the reverse! Actually, the extreme reliability with which Struthers-Dunn Type 78CCA100 Relay holds its adjustments is the direct result of its new simplified and rigid design which utilizes an absolute minimum of parts.

Originally made for aircraft use, it weighs little, is exceptionally sturdy, and has all parts readily accessible. Tests show a minimum life of five million operations.

The Relay has seven poles, including one double-throw pole which handles high-voltage radio frequency currents by means of a vacuum switch. All high-voltage parts are rounded to reduce corona.

Write for complete details, or get in touch with your nearest Struthers-Dunn Field Engineer.

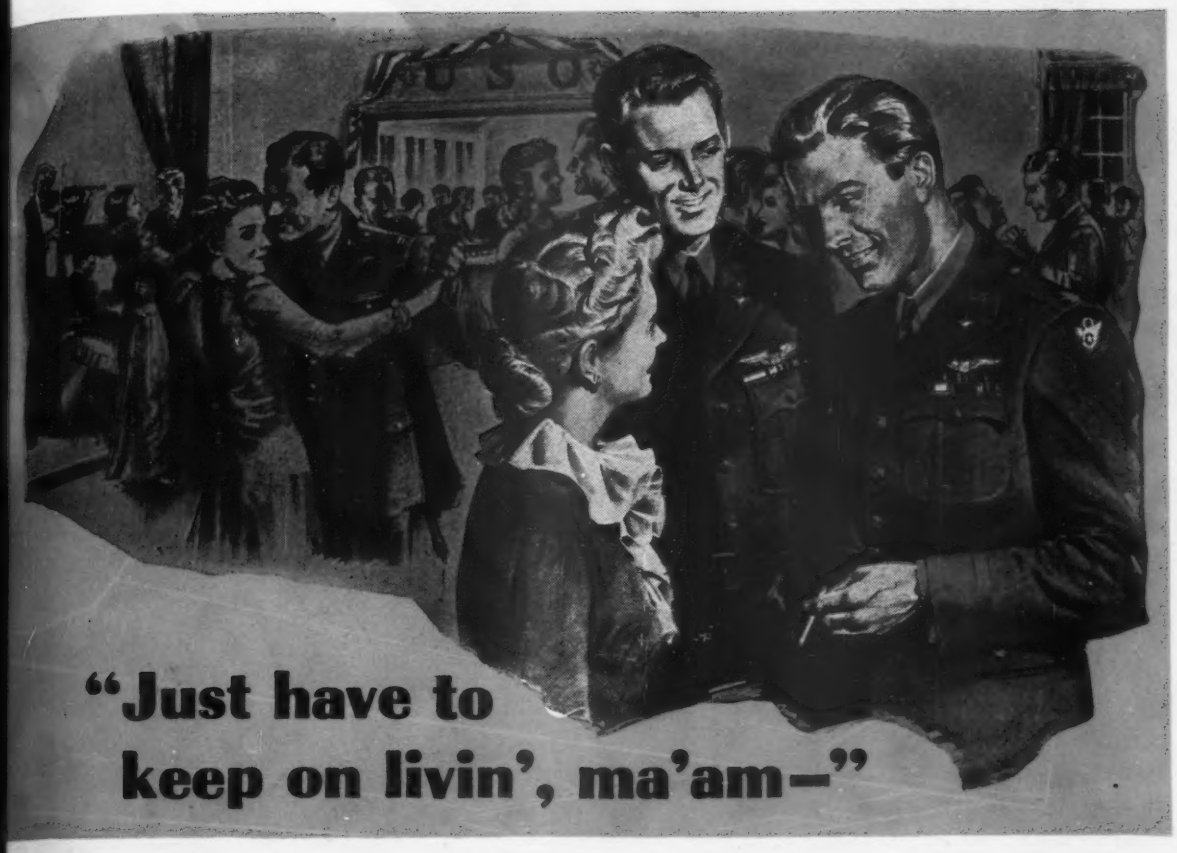
STRUTHERS-DUNN, Inc.
1321 ARCH STREET PHILADELPHIA 7, PA.

ONE OF THE

STRUTHERS-DUNN

5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA · BALTIMORE · BOSTON · BUFFALO · CHICAGO · CINCINNATI · CLEVELAND
DALLAS · DENVER · DETROIT · HARTFORD · INDIANAPOLIS · LOS ANGELES · MINNEAPOLIS · MONTREAL
NEW YORK · PITTSBURGH · ST LOUIS · SAN FRANCISCO · SEATTLE · SYRACUSE · TORONTO · WASHINGTON



"Just have to keep on livin', ma'am—"

The U.S.O. hostess recognized wings, and rank, but the face was too young for the silver leaf on his shoulder.

"Heavenly day!... How do you Air Force boys run up so much rank so fast?" she asked.

"You just have to keep on livin', ma'am," said the youthful 8th Air Force Lieutenant Colonel . . . and he wasn't being at all facetious!

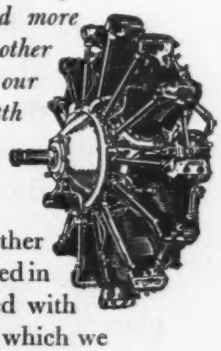
Since last summer they have been trickling back . . . with rows of ribbons under their wings, foreign service stripes, and the shoulder patch with the "8" between the spread wings of the Air Forces emblem. Too few of us know either the marking or its meaning.

The 8th Air Force began with the first few Flying Forts sent to England in early 1942 . . . proved that precision bombing by day was practical—and deadly . . . fought with the R.A.F. 500 miles deep in Fortress Europe despite 40,000 anti-aircraft guns, Focke-Wulfe fighters . . . and sickening losses to the original group.

With 1943 came reinforcements; but the Ploesti oilfields cost 54 bombers, the two Schweinfurt raids 96. Before the year's end, 60% of the flying personnel were dead, wounded, listed as missing, prisoners of war. At its peak in Spring 1944, the 8th lost in one fateful week in February 170 bombers, downed 548 German fighters, broke the back of the vaunted Luftwaffe.

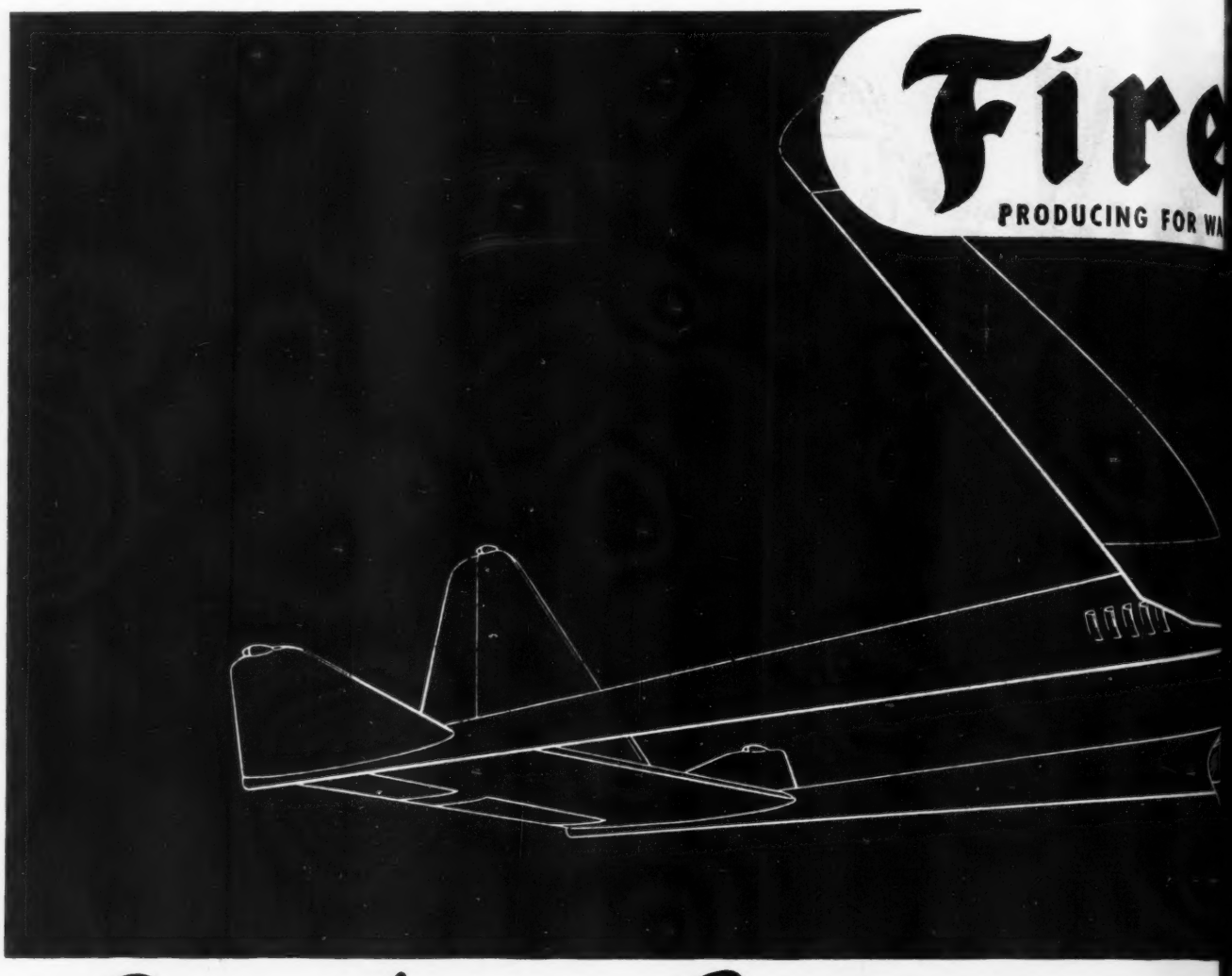
In a year of hard, persistent fighting, the 8th battered the German war machine and its industries, shriveled Nazi nerves. When D Day came, American armies never met the full strength of the mighty Wehrmacht, but an enemy weakened by disorganized communications and supply lines.

What most Americans fail to realize is that the 8th Air Force saved the lives of hundreds of thousands of doughboys, shortened the European war by perhaps a year . . . earned more decorations and citations than any other military unit in history, as well as our undying gratitude. Watch for the 8th shoulder patch and honor the men who so proudly wear it!



Many of the 8th Air Force and other AAF bombing personnel were schooled in twin-engine training planes powered with engines made by Jacobs . . . a fact of which we are justly proud . . . Jacobs Aircraft Engine Company, Pottstown, Pa.

JACOBS · **Pottstown, Pa.**



Give Your Customers a

...IN YOUR POST-WAR PRIVATE

YOU HEAR a lot of different opinions about the postwar outlook for the aircraft industry. Some people say that the number of private planes will grow like Jack's beanstalk. Others say that there just aren't enough people with money enough to buy their own planes and who are also able to pass the C.A.A. tests.

But one thing is certain — aircraft manufacturers are planning now to build private planes that are better and cheaper and safer than the prewar models. And one of the big improvements they are incorporating into their designs are Firestone wheel and hydraulic brake assemblies.

Equipped with Firestone Tires and Tubes the Firestone wheel and brake assembly is, for safety and kinetic energy capacity, the lightest airplane braking unit on the market. In dependability it is unsurpassed — tests under all conditions have failed to produce a locked brake and it will not freeze in winter or overheat and grab in summer.

FIRESTONE AIRCRAFT COMPANY, AKRON, OHIO • LOS ANGELES, CALIF

TIRES, TUBES, WHEELS, BRAKES, AIR SPRING LANDING GEARS, BATTERIES, SPARK PLUGS, COVERING, FOAMEX CUSHIONING, FUEL AND OIL CELLS, BUSHINGS AND MANY OTHER

estone

. . PREPARING FOR PEACE

a BRAKE

PLANES

Would you like full information about Firestone wheel and brake assemblies? A letter, wire or phone call will bring you complete data or a trained aircraft engineer, without cost or obligation.

For the best in music, listen to the "Voice of Firestone" with Richard Crooks and Gladys Swarthout and the Firestone Symphony Orchestra conducted by Howard Barlow every Monday evening over NBC network.

© 1945, The Firestone Tire & Rubber Co.

. . . . MAKERS OF
VELON SEAT
AIRCRAFT SUPPLIES

Blackout For Exhaust Flames!

Burning exhaust gases no longer "spot" night-flying planes for enemy observers . . . thanks to the Solar flame damper which suppresses the tell-tale flames, reduces plane visibility and has greatly increased the effectiveness of night combat operations.

Solar engineers have played a major part in the development of flame dampers because the design and fabrication of products which must withstand high operating temperatures and severe vibrations, possess great structural strength, yet be light in weight, has been Solar's specialized activity for fifteen years.

As the leading manufacturer of airplane exhaust systems and other high temperature alloy products for the elimination of gases, the utilization of waste heat energy, and the control and transfer of heat, Solar has become the recognized authority. Its services are available to aircraft manufacturers with such problems.

ARMY ★ E ★★ NAVY ARMY ★ E ★★ NAVY

SOLAR

STAINLESS STEEL PRODUCTS

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO 12, CALIF. ★ DES MOINES 5, IA.

Aeroprops for the Planes of Peace

Reliability and Automatic Operation of this General Motors Propeller add New Ease to Flight

PASSENGERS in tomorrow's planes will fly with serene confidence, thanks to the brilliant engineering developments of recent years. Important among these developments is the Aeroprop, the war-proved General Motors propeller.

The Aeroprop combines greater lightness with maximum strength—simplicity with utmost reliability. Under powerful hydraulic control, the Aeroprop automatically adjusts its pitch to meet changing flight conditions, moving from low pitch to full feather in only five seconds.

Weight reduction is achieved through use of hollow blades which are steel-ribbed for strength. Simplified design and fewer parts mean reduced wear, quick inspection, and maintenance economy.

These features—each contributing to the reliability of the propeller—distinguish the thousands of Aeroprops that have helped American planes dominate the skies. These same engineering achievements of General Motors research will serve the millions who will fly in the coming years of peace.

Aeroprop Advantages—*Lightness* for payload . . . *Strength* for safety . . . *Simplicity* for easy service . . . *Faster Automatic Pitch Change* for flight efficiency . . . *Full Feathering* for engine protection . . . *Engineered* for reliability.

Aeroprop

The Lighter, Stronger, More Reliable Propeller

AEROPRODUCTS DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

GM ARMS FOR VICTORY

Keep them flying—Buy Another War Bond!

A Whole Flock of Advantages

Apex bit holders and "removable bits" revolutionize the use of Power Bits and Hand Drivers for Phillips Recessed Head Screws. Look at these advantages:

1. Once you buy the holders you need, you carry a stock of insert bits only. One range of inserts fits various sized holders.

2. Cut your production costs because inserts are very low in price.

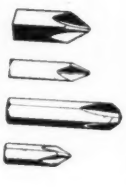
3. Float between holder and bit means less wear on the point because bit and screw recess align easily and accurately.

4. Return of used bits for reconditioning is unnecessary. Cost of inserts is approximately the same as reconditioning charge.

APEX

THE APEX MACHINE & TOOL COMPANY • DAYTON 2, OHIO

Meet the family of Apex-Phillips Insert Drive Bits



Four sizes—1/4" hex, 5/16" hex, 1/4" square and 5/16" square comprise the entire range of inserts with their various Phillips point sizes for our complete range of holders. Send for Bulletin 102, describing this type of bit and Apex Holders to fit practically every make of power drive.

THINK of it! One-fourth shorter takeoff runs! One-third higher rate of climb! Cruising faster and farther at the most favorable altitude! All with minimum fuel consumption and engine wear. That's what Aeromatic—*the one and only self-acting variable pitch propeller*—means for that postwar plane of yours. And it means long glides for happy landings—with an instantaneous change of pitch for a quick pickup if you overshoot the field.

Completely self-contained and self-acting, the Aeromatic Propeller requires no instruments . . . no controls . . . nothing extra for you to watch or do. Responding to natural forces, it automatically assumes the correct pitch for peak efficiency under all flight conditions. It lets your plane and engine deliver automatically, as no other propeller can, *all* the performance that is built into them . . . with safe, simple, economical operation that makes flying real fun.

If you fly, or plan to fly, you will want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder, containing a diagram of the "brain" in an Aeromatic, drop us a line. We'll be glad to hear from you.

The Propeller with a Brain for Tomorrow's Plane

Aeromatic

Air Controlled *Automatic Propeller*

KOPPERS Co., Inc., Bartlett Hayward Division, Baltimore 3, Md.

Licensed under patents of EVEREL Propeller Corporation

How are you at Chopping Trees?

No, this is no joke. Many businessmen have volunteered to aid the paper shortage by spending vacations from their companies in the timber country, helping out on the man-power problem in the paper pulp industry.

Not that you have the time to do this. Nor that tree-chopping is exactly in your line. But, until the man-power shortage in this vital industry is over, until our armed forces no longer are spread all over the world where food, ammunition and medical supplies must be shipped them in paper protection wrappers, there is a chopping job you must do. You must chop the use of paper in your business.

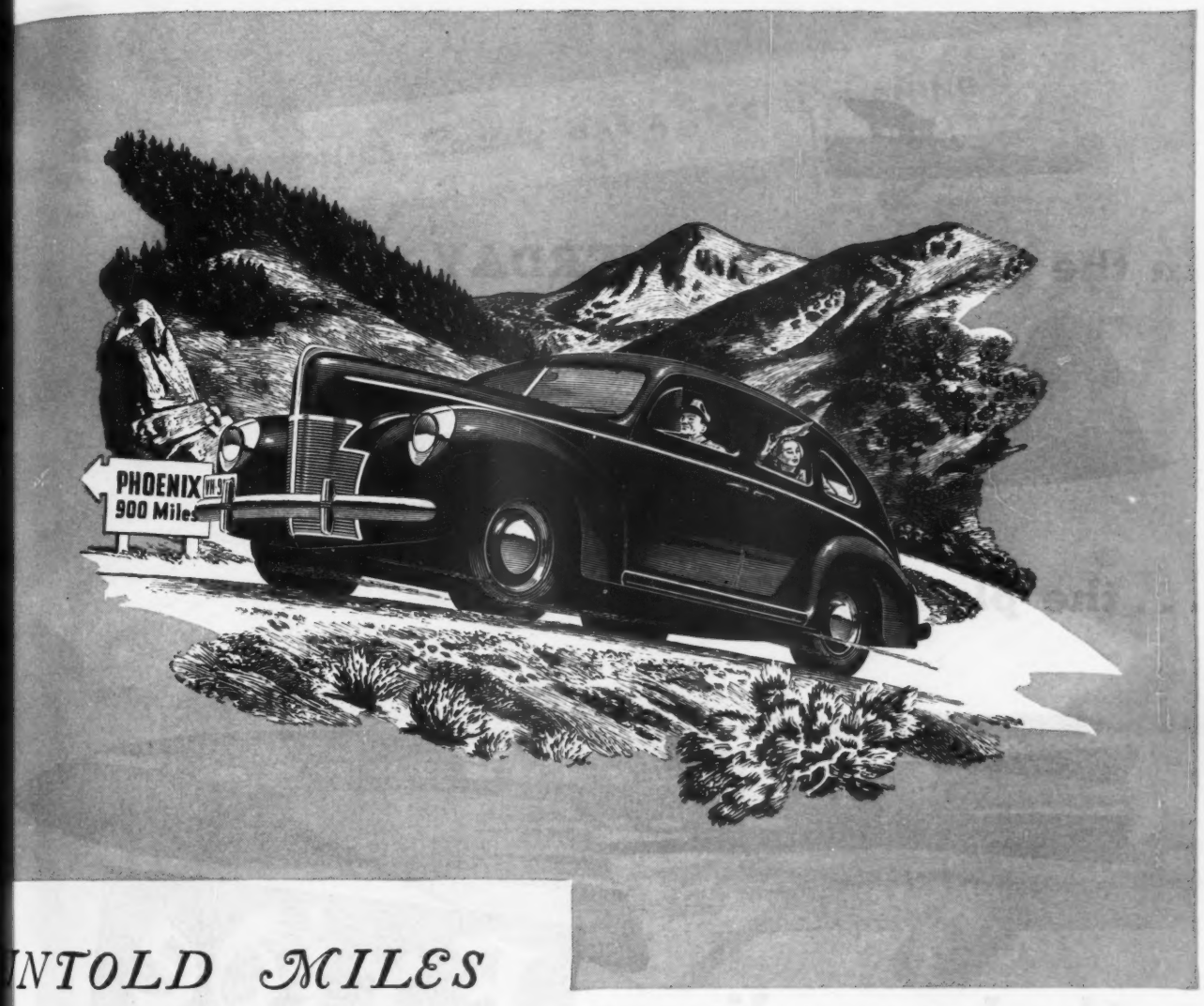
Sure, you've done plenty of this in the past months. But right now the need for paper is greater than ever. So the government asks you again to examine paper usage in your firm, see if you can't make even further savings.

And don't forget that baling wastepaper and sending it to a reprocessing plant is a most important part of the paper conservation job.

Remember—
PAPER IS WAR POWER

USE LESS PAPER—SAVE ALL WASTEPAPER

This advertisement contributed by this publication and prepared by the War Advertising Council in cooperation with the War Production Board and the Office of War Information.



UNTOLD MILES OF CARBURETOR DEPENDABILITY

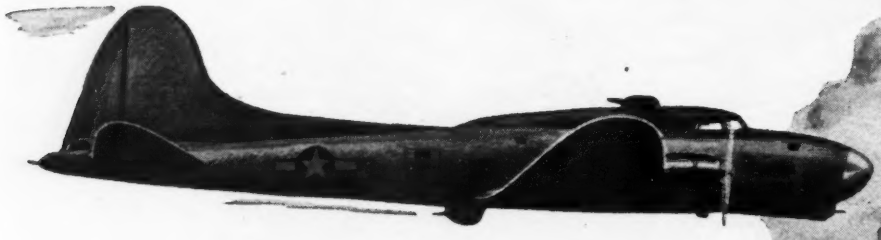
Untold millions of miles have been driven on Holley Carburetors. They are known all over the world for their outstanding record of dependability. For almost half a century, Holley research, design and precision production have contributed importantly to engine efficiency, economy and performance. Peacetime motoring will find this same dependable carburetor performance available to all.

HOLLEY

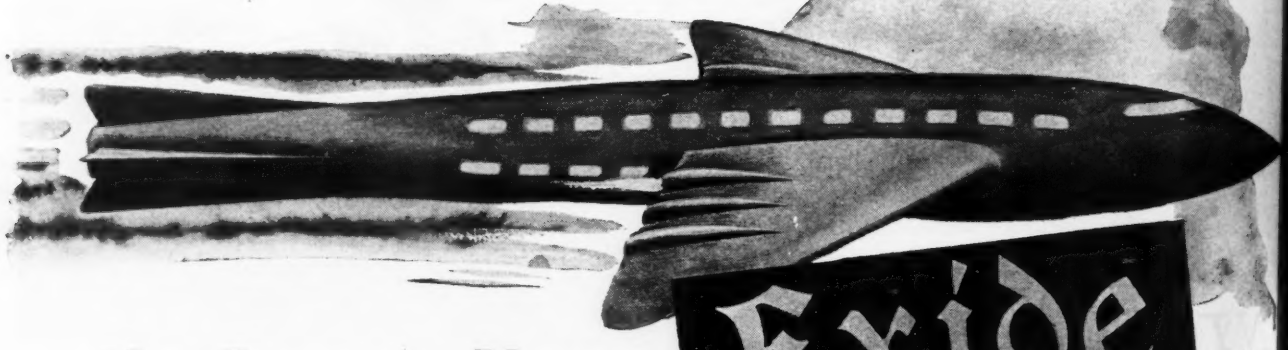
AIRCRAFT, AUTOMOTIVE, MARINE

CARBURETORS AND ACCESSORIES

In the aircraft of YESTERDAY



... the planes of TODAY



...the luxury liners of TOMORROW

Exide
AIRCRAFT BATTERIES

FROM the time when storage batteries first became a factor in aircraft design and operation up to the present day, Exides have been the preferred battery for equipment and replacement. This preference is a natural result of a deserved reputation for dependability, long-life and ease of maintenance.

And when tomorrow's liners, cargo carriers and other flying craft are traveling the airways, Exide performance will continue to measure up to aviation's battery needs. For Exide development is keeping steadily in step with the fast pace that aviation engineering has set.

A LETTER FROM INDIA

Interesting letters are frequently received from some of the more than 1400 Exiders in the Service. This one comes from India:

"No matter where I go—Mojave Desert, North Africa, India—Exide Batteries still continue to spark me in the eye. That's not hard to take."

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

IN ELECTRONICS "*Quality*" HAS A SPECIAL MEANING

Quality

*At Amphenol all U.H.F. Cable is thoroly inspected and must bear affidavit of test approval before shipment.

Extra significance is attached to the whole idea of *Quality* when it applies to electronic equipment. High-frequency currents make special demands of a technical nature that go far beyond the standards of good material and high quality workmanship.

Such requirements are a familiar story to Amphenol, one of the pioneers and leaders in the low-loss transmission equipment field. Amphenol makes the most complete line of both solid dielectric flexible U.H.F. Cables and U.H.F. Connectors and they are now being produced in tremendous volume.

Actually Amphenol's own tests and inspections go beyond required performance and tolerances. Amphenol tests for *outstanding quality* assure dependable performance under the most difficult of conditions.

Depend upon

AMPHENOL

Quality

U.H.F. Cables and Connectors
Conduit Fittings
Connectors (A-N, U.H.F., British)
Cable Assemblies
Radio Parts
Plastics for Industry

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada, Amphenol Limited, Toronto

Amphenol U.H.F. Coax Cables with Amphenol Low-Loss Connectors.

PAY-OFF ON A PURPOSE

Allison's objective for 30 years has been to exact the most work from the fewest ounces of metal. ★ The pay-off on such effort can be appraised in the performance of the 65,000 smooth-running Allison engines powering Army Air Forces planes on every fighting front. It can be seen in the powerful 24-cylinder Allison "3420's". ★ Allison's rare proficiency in precision with metals will pay off, too, in the planes of peace—emphasizing those qualities which make your flying enjoyable. ★ And this same precision will endow any Allison product with the ability to serve you precisely right.

POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51—Mustang
P-63—Kingcobra

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF GENERAL MOTORS

Indianapolis, Indiana

KEEP AMERICA STRONG BUY MORE WAR BONDS

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR—*NBC Network*

The Greeks gave us a word for it... now we give it to *you*

WHEN Sperry first developed its velocity-modulated, ultra-high-equency tube, the word "KLY-TRON" was registered as the name the new device.

This name — from the Greek, as ined by scientists of Stanford Uni-rsity — is an apt description of the nching of electrons between spaced ids within the tube.

"Klystron" is a good name. So od, that it has come into wide-read use as the handy way to des-nate *any* tube of its general type, whether a Sperry product or not.

This is perfectly understandable. For the technical description of a Klystron-type tube is unwieldy, whether in written specifications, in conversation, or in instructing members of the Armed Forces in the operation of devices employing such tubes.

These conditions have prompted many requests from standardization agencies—including those of the Army and Navy—for unrestricted use of the name Klystron. In the public interest, Sperry has been glad to comply with these requests...

From now on, the name KLYSTRON belongs to the public, and may be used by anyone as the designation for velocity-modulated tubes of any manufacture.

Sperry will, of course, continue to make the many types of Klystrons it now produces, and to develop new ones.

On request, information about Klystrons will be sent, subject to military restrictions.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

Division of the Sperry Corporation

★

LOS ANGELES • SAN FRANCISCO • NEW ORLEANS
HONOLULU • CLEVELAND • SEATTLE

ROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

READY AND WAITING

To Hurl t
Snow From the Runwa

★ Where SNOGO equipment is used, snow is re
in a *minimum of time* from the runways of airports, helping t
a great part of the costly interruption to flying schedules oth
caused by snowfalls.

During Winter storms, SNOGOS are as essential to airports
radio which sends the "beam" to the pilots, the landing lights
traffic control. SNOGOS keep runways clear—never pile up
of snow to endanger wing tips—never leave a heavy snow
necessitating continuous compaction tests or reconditioning
rolling and sanding. There is no packed layer to freeze into dan
ruts or thaw into rotten danger spots and provide slush to be
up by wheel pants and freeze in wheel wells or brakes.

Where the field must be completely cleared SNOGO is the
known method of loading snow. Where compaction must be
provide an "allway field" the easy handling of SNOGO
ability to stay up "on top" means time saved. SNOGO equ
pays for itself when it prevents the first washout!

SNOGO A SNOGO For EVERY BUDGET

KLAUER MANUFACTURING CO
DUBUQUE, IOWA

2044 A.D.

Still young at 99..

It is really worthwhile to use a *permanent* tracing paper, for you never can tell when an old drawing may have to be consulted or reproduced. In many drafting room files there are drawings on ALBANENE that are years old, but are still in perfect condition, and should stay that way for 99 years or more. Protect your designs, your inventions, your business itself—use ALBANENE!

ALBANENE Tracing Paper is treated with Albanite, a crystal-clear, unaltering synthetic developed by the K & E Laboratories. So far as the most severe tests show, it should last almost forever. The paper itself is 100% white rag stock. The Albanite not only makes it ageless but extra transparent. And because ALBANENE stays white, it gives strong, contrasting prints. It's fine to work on too, with pencil or ink—keeps clean and takes erasures well. Comes in rolls, sheets, and pads. Write on your letterhead for sample sheet.

K+E

Drafting, Reproduction, Surveying Equipment and Materials Slide Rules, Measuring Tapes

Albanene

REG. U. S. PAT. OFF.

KEUFFEL & ESSER CO.

EST. 1867

NEW YORK • HOBOKEN, N. J.

CHICAGO • DETROIT • ST. LOUIS • SAN FRANCISCO • LOS ANGELES • MONTREAL

Protected by ONE Cardox Fire

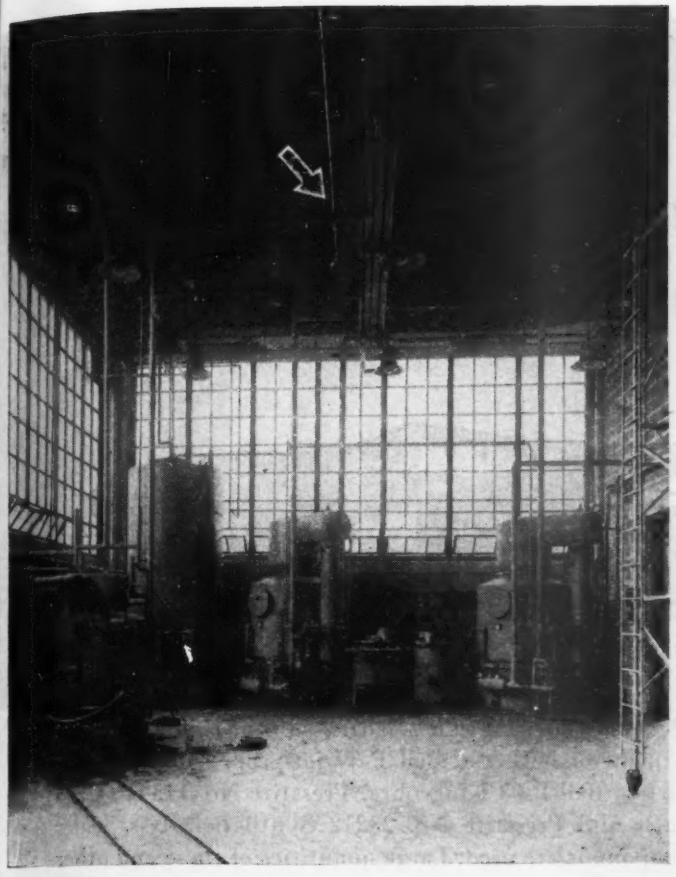
The five oil processing and storage rooms illustrated here . . . plus four others and a long pipe tunnel that could not be photographed . . . represent a major fire hazard in one of America's large war plants. All nine rooms and the pipe tunnel . . . 941,140 cubic feet . . . are guarded by *a single* engineered Cardox Fire Extinguishing System.

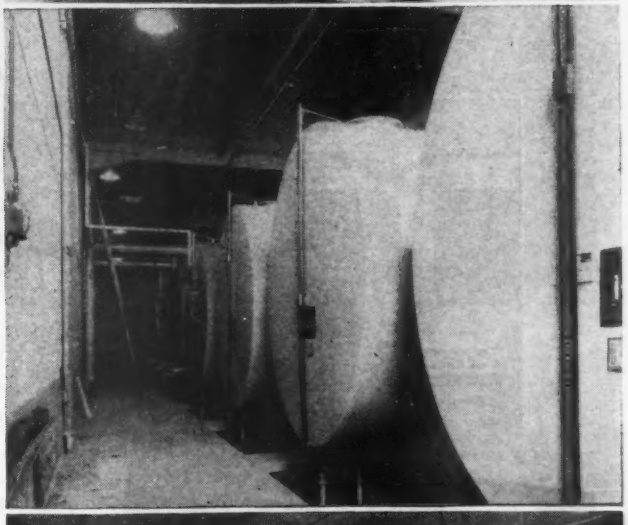
Total flooding of any of these rooms with inert carbon dioxide and CO_2 snow is provided by 12 tons of liquid Cardox CO_2 as soon as fire strikes . . . with substantial reserve for new emergencies.

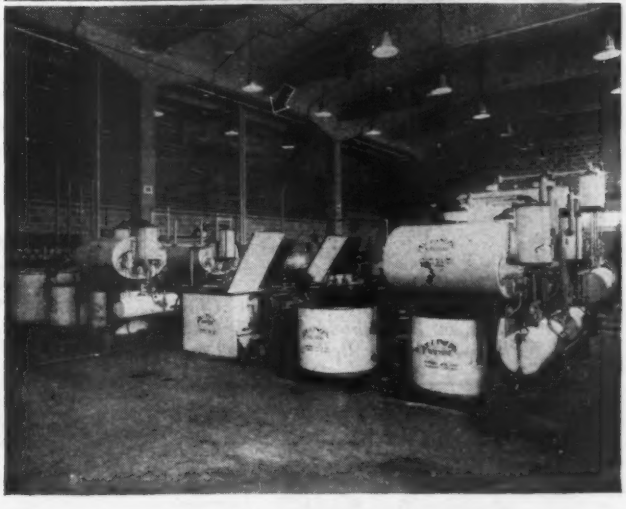
Here is only one of hundreds of examples of how engineered Cardox Fire Extinguishing Systems utilize fast-acting, non-damaging, inexpensive carbon dioxide to provide enhanced extinguishing performance in protecting *large* and *small* hazards.

The enhanced extinguishing performance of carbon dioxide, as controlled and applied in Cardox Systems, is due to these four basic factors: (1) It has uniform extinguishing characteristics regardless of plant or atmospheric temperatures; (2) It is available in ample quantity for application at high rate and for total flooding (when necessary) of large areas; (3) It provides high CO_2 "snow" yield for increased cooling effect; (4) It achieves effective projection through relatively great distances—even outdoors.

The hazards in your plant may not be as *large* as those shown here, but the kind of extinguishing performance that has caused Cardox Systems to be specified for guarding hazards such as these has a place in your fire protection plans. Cardox engineers offer you practical cooperation.







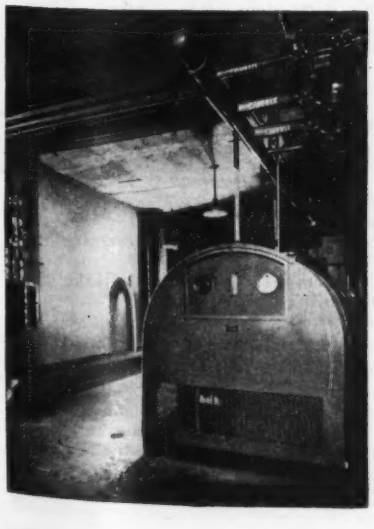
Extinguishing System

Write for details and Bulletin 325.

CARDOX CORPORATION

BELL BUILDING • CHICAGO 1, ILLINOIS

New York • Boston • Washington • Detroit • Cleveland
Atlanta • Pittsburgh • San Francisco • Los Angeles • Seattle



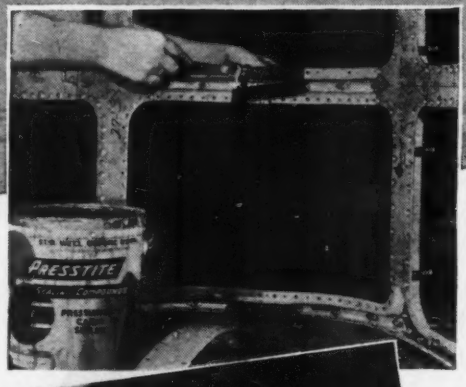
All of the areas illustrated here represent Class B hazards . . . involving volatile and flammable liquids. Total flooding with Cardox CO_2 is applied at the highest practicable rate to create an extinguishing concentration in the minimum length of time. An adequate supply of liquid carbon dioxide to cover all of the hazards illustrated is maintained in a single refrigerated Cardox Storage Unit similar to one pictured at left.

CARDOX
CO_2 FIRE EXTINGUISHING SYSTEMS

PRESSTITE Compounds Seal the Cabin on the Bell Jet-Propelled Airacomet!

The P-59 Airacomet in Flight

Applying Presstite Cabin Sealer to Hatch of the Bell P-59



Applying Presstite Synthetic Glass Sealer to Windshield of Bell P-63. Photos, Courtesy Bell Aircraft Corp.

To assure air and water tightness in the cabin compartment of both the Bell P-59 jet-propelled Airacomet and the Bell P-63 Kingcobra, Presstite No. 11544 Cabin Sealer and Presstite No. 23212 Synthetic Glass Sealer Compounds are used. Large quantities of these and other Presstite Sealing Compounds are also used in the construction of the Bell-built, Boeing-designed, B-29 Superfortress.

Thus another famous aircraft builder joins the many who rely on Presstite sealing compounds for many vital uses which include the sealing of fuselage seams, gun turrets, fuel tanks, seaplane floats, etc.

To industry at large, Presstite offers the same engineering skills and technical knowledge that led to the development and manufacture of such compounds as those mentioned above. Thoroughly proven in both war and peace, Presstite Sealing Compounds are the result of highly specialized experience in the whole sealing field.

Whatever your own sealing problem may be, or your need for coatings and adhesives, call on Presstite's knowledge. We'll gladly work with you right now on *any* sealing requirement.

PRESSTITE
SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY, 3910 Chouteau Avenue, St. Louis 10, Missouri

A Partial List of Industries for Which Presstite has successfully Developed Special Sealing Compounds:

For the Aircraft Industry:
Sealers for
- Integral Fuel Tanks
- Fuselage Seams
- Drop-off, Expendable Fuel Tanks
- Gun Turrets
- Synthetic Glass
- Instruments
- Intercoolers
- Air Ducts
- Insulating Dissimilar Metals
- Seaplane Floats

For the Refrigeration Industry:
Sealers for Domestic and Commercial Refrigerators
Bonding and Sealing Low Temperature Insulation in Refrigerated Rooms

For the Railroads:
Sealers for Insulating, Soundproofing and Weatherproofing of Railway Cars—Sealing Car Windows and Spot Welded Seams

For the Building Industry:
Roof Coatings, Caulking, and Waterproofing Compounds

For the Radio Industry:
Sealers for radio panels and cases, coil impregnation — many communication equipment applications.

For the Automotive Industry:
Special Adhesives and Sealers

For the Construction Industry:
Sealers for Jointing Sewer Pipes
Sealers for Waterproofing Excavation Work

Miscellaneous:
For Glazing Greenhouse Windows
Extruded Caulking Compounds
Ammunition Paints
Plus Many Special Products for the Army and Navy

Our Engineering, Technical, and Laboratory facilities are at the service of any industry with a sealing problem.

Maker of Air History—
The Boeing Superfortress

Photos Courtesy Boeing Aircraft Company

Belden AN-JC-56 Spark Plug Wire

Belden AN-JC-48 Shielded Tropicalized Lighting Wire

Belden AN-JC-48 Tropicalized Power Cable

Boeing employee assembling a wiring harness. Belden wire is used in this operation.

—AND HERE'S ANOTHER PLACE WHERE BELDEN WIRE GOES TO WAR

The Boeing Superfortress, heavily armored and armed with formidable gunpower, serves pilots of the 20th Air Force as a vital weapon of attack. Powered by four huge engines and with a tremendous range, it figures prominently in recent news of bombings of Japan.

Service under battle conditions has rated the Superfortress an achievement for its makers. Into it the Boeing Aircraft Company put the skill of its engineers, the craftsmanship of its employees, and the dependability of service-tested materials. The Boeing Superfortress is another place where Belden wire goes to war.

Belden wire meets such strenuous requirements with plus values built into it through years of testing, experimenting, and collaboration with aircraft engineers. Controlled production has given it the qualities to meet aviation's current needs. Belden Manufacturing Company, 4665 W. Van Buren St., Chicago 44, Illinois.

Belden *Aircraft* WIRE

Awarded the U. S. Treasury Special Citation of Merit for Initiating the War Bond-or-Cash Dividend Plan

Starter, Lighting, and Instrument Cables √ √ √ SPARK PLUG WIRES

COMPRESSED AIR... Speeds Aircraft Maintenance

This lightweight drill speeds repairs on the tail section of a transport plane in the PAA hangar at Miami.

Air tools play a big part in keeping aircraft "flightworthy."

Air tools are lighter in weight and easier to handle than other power tools of equal capacity.* Air tools can be started and stopped instantly. Torque and speed can be varied throughout the capacity range – full power is available at the squeeze of the throttle.

Your operators can do an easier, quicker and better job with air tools. The I-R line includes drills, riveters, grinders, wrenches, and many other labor-aiding air tools.

For your compressed air supply you can choose from the wide range of I-R stationary and portable compressors. There is a size and type to fit every application.

Let the nearest Ingersoll-Rand engineer give you the facts.

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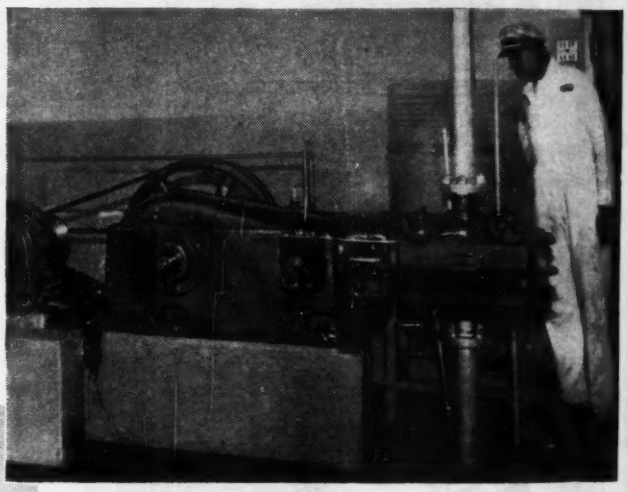
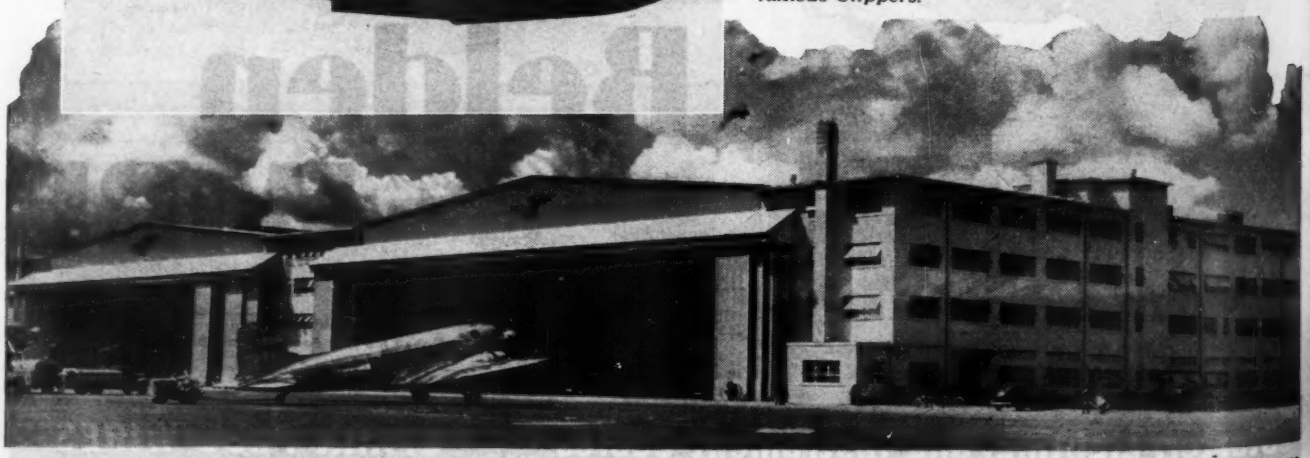
Photos courtesy Pan American World Airways System 8-465



Single-stage, Type ES heavy-duty compressor which supplies air for many uses at the PAA Airport in Mexico City.

View of the modern airport of the Pan American Airways System in Miami. Inset shows one of the famous Clippers.



COMPRESSORS • TURBO BLOWERS • AIR TOOLS • ROCK DRILLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

How Orco can help You

ON PROBLEMS INVOLVING RUBBER AND SYNTHETIC RUBBER

DEVELOP NEW PARTS

Where component units of new products may require a combination of properties in a single material, ORCO can help you explore the possibilities of rubber and synthetic rubbers.

OBTAIN IMPROVED WEARING QUALITIES

If you seek improved resistance of rubber and synthetic rubber parts to conditions causing excessive wear, ORCO may help you by developing an improved compound.

CONTROL VIBRATION

Elimination or reduction of vibration, shock, and noise in moving parts of machinery involve problems on which ORCO is prepared to co-operate on every phase of vibration isolation.

DETERMINE BEST SYNTHETIC RUBBER FOR SPECIFIC NEEDS

ORCO offers you an impartial source of information regarding the comparative advantages of all commercially available synthetic rubbers as applied to any stated specifications.

CONDUCT LABORATORY AND FIELD TESTS

ORCO research activities comprise modern laboratory equipment and an experienced technical staff available for complete co-operation "from test tube to field test."

SOLVE PROBLEMS OF BONDING RUBBER TO OTHER MATERIALS

Adhesion processes for bonding rubber and synthetic rubbers to metals and a wide variety of other materials are highly specialized services available to you at The Ohio Rubber Company (ORCO).

DESIGN EFFICIENT MOLDS AND DIES

When required, ORCO offers complete service in the engineering of molds and dies to meet your specifications for mechanical molded or extruded rubber and synthetic rubber parts.

ENGINEER SPECIAL TOOLS AND EQUIPMENT

If your requirements call for special tools and equipment for efficient, large-scale production, ORCO maintains a specialized engineering service.

REDUCES COSTS THRU IMPROVED METHODS

Unusual "flexibility" of ORCO production facilities assures improved methods to minimize costs on both small or large volume requirements on either intermittent or continuous runs.

IN ONE WORD, WE OFFER YOU

"ORCO-OPERATION"

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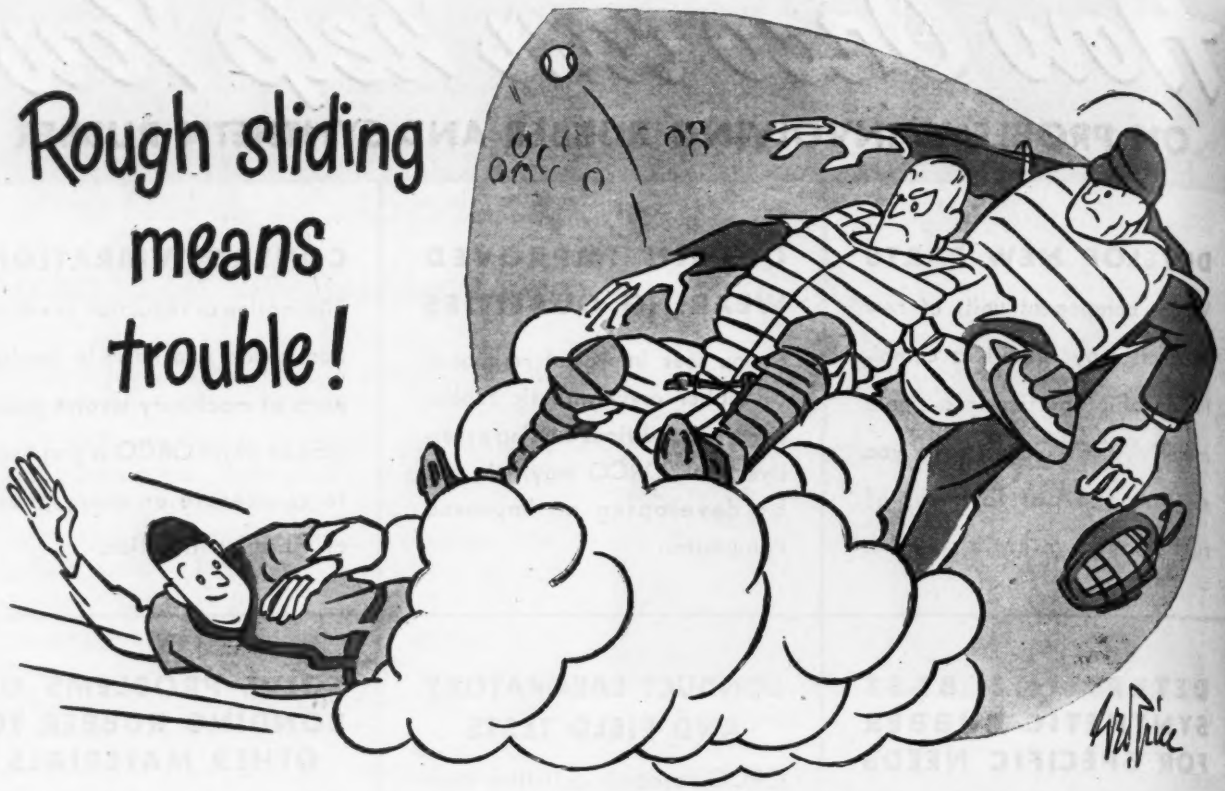
Rough sliding means trouble!



Exclusive Crown Zipper tooth construction assures quick, smooth, effortless sliding, even around sharp curves!

Look at a Crown Zipper closely, and what do you see? Each individual tooth is identical on both sides!

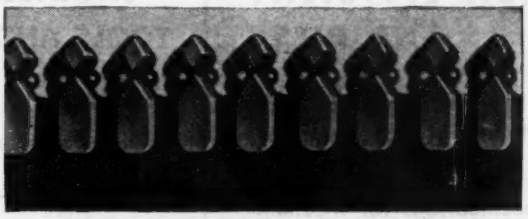
This exclusive Crown design permits the sliders on Crown Zippers to move with perfect freedom in both directions along the zipper track.

Even on heavy aircraft and truck-tractor covers, Crown Zippers operate quickly, smoothly, almost effortlessly—take sharpest curves without sticking or bunching the fabric.

This big, basic Crown Zipper advantage is but one of *many* Crown superiorities that will make for better service in postwar aircraft equipment applications.

Actually, Crown engineers, working in the field with our armed forces, have developed *five* advancements over old-style, conventional zippers. (See complete list of Crown Zipper superiorities below.)

When *you* turn to postwar, Crown's great backlog of experience in improving zipper design and in adapting zippers to meet special jobs will be invaluable. For our designers will sit down with your own designers to adapt—or, if necessary, *create*—special zipper applications to meet your individual manufacturing needs.



ONLY CROWN ZIPPER TEETH ARE IDENTICAL ON BOTH SIDES, TO INSURE SMOOTH SLIDING!

CROWN ZIPPERS are 5 ways better

1. Takes sharp curves

2. Die-cast for smoother action—extra strength

3. Provides opening wherever you want it

4. Won't lock open

5. Resists corrosion

Member of the J. & P. Coats • Clark's ONT *Family*

THE SPOOL COTTON COMPANY • *745 Fifth Avenue, New York, N. Y. (Crown Fastener Division)*

W. A. PATTERSON, *President of United Air Lines*

"...YOU SAY VIBRATOR POWER SUPPLIES CAN INCREASE SAFETY AND COMFORT IN PLANES?"

MR. W. A. PATTERSON, *President of United Air Lines, recently said—*

"It is our belief that the war has advanced public acceptance of the airplane as a mode of transportation by 20 years. The airlines, like every other service that caters to the public, must anticipate their passengers' expectations of new facilities for greater comfort and safety. United will put in service new, huge 44-50 passenger Mainliners offering comforts, conveniences and thoughtful appointments surpassing anything heretofore known, and flying from coast to coast in 11 hours with new devices to assure safe flight."

E-L is ready right now with Vibrator Power Supplies to bring passengers the greater comfort of fluorescent lighting as well as the convenience and safety of radio and radio-telephone. E-L Black Light equipment is available as a safety device for instrument panel illumination at night to eliminate blinding interior glare and to provide clear, sharply defined instrument calibration. Engineered to specific space and voltage requirements, Electronic Laboratories products are used wherever current must be changed in voltage, frequency or type. E-L engineers invite inquiries.

THE X-244 LIGHT

Black Light Illumination is required equipment on new military planes. The X-244 Light provides both ultra-violet (black) or invisible light and white light. Iris Control Ring offers easy selection of desired intensity and type of light. Operates on 28 volts and weighs 15 ounces installed, including resistor board and cords. Quickly detachable for use as emergency cockpit light.

Further Information on Request

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Electronic LABORATORIES INC.

INDIANAPOLIS

VIBRATOR POWER SUPPLIES FOR LIGHTING, COMMUNICATIONS, AND ELECTRIC MOTOR OPERATION • ELECTRIC, ELECTRONIC AND OTHER EQUIPMENT

"AND I SEE "Spring-life" BELLOWS IN THOUSANDS OF NEW POST-WAR APPLICATIONS"

Thanks, Swami, but we know that! We have already heard from thousands of engineers and designers who want to know more about the 7 advantages of Cook "Spring-life" Bellows. Engineers and designers who realize that "the best equipment needs the best components," but what we want is the names of the men who do not know the full story of "Spring-life" Bellows and how they go beyond the scope of ordinary bellows applications.

We know that "Spring-life" Bellows construction has opened a wider field for post-war bellows applications. We know that after "Spring-life" Bellows have made their final contribution to the winning of the war, they will be incorporated in some of the finest post-war equipment because, despite the largest war-time back-log of orders, our engineers are still managing to cooperate with other manufacturers in the designing of numerous post-war projects.

THE 7 ADVANTAGES OF "SPRING-LIFE" BELLOWS CONSTRUCTION

1. **CHOICE OF METALS.**
2. **UNLIMITED OUTSIDE DIAMETERS AND LENGTH** — Cook "Spring-life" construction places no limits on the outside diameters or the length of bellows.
3. **WIDE RANGE OF SENSITIVITY** — Flexibility varies directly with the number of flanges and type and thickness of metals used.
4. **CALIBRATION** — Cook "Spring-life" Bellows are particularly suitable for applications requiring extreme accuracy and spring-rate, as well as zero hysteresis. "Spring-life" Bellows may be calibrated to function in direct relationship to increments of pressure, and with exacting linear travel.
5. **UNIFORM MOVEMENT** — Because Cook Bellows are made of tempered materials, they maintain a uniform movement in operation, and assure exact return to the "no load" position.
6. **LONGER LIFE** — Extensive life tests have proven that Cook "Spring-life" Bellows can "take it" far and beyond any ordinary seamless type of bellows. Tests have shown that 600 million flexures cannot weaken "Spring-life" Bellows of phosphor bronze construction.
7. **GREATER ADAPTABILITY** — Because of the above advantages, Cook Bellows open a wider field of bellows applications, involving temperature, pressure, dimensional response, corrosion resistance, sensitivity and inherent spring-rate.

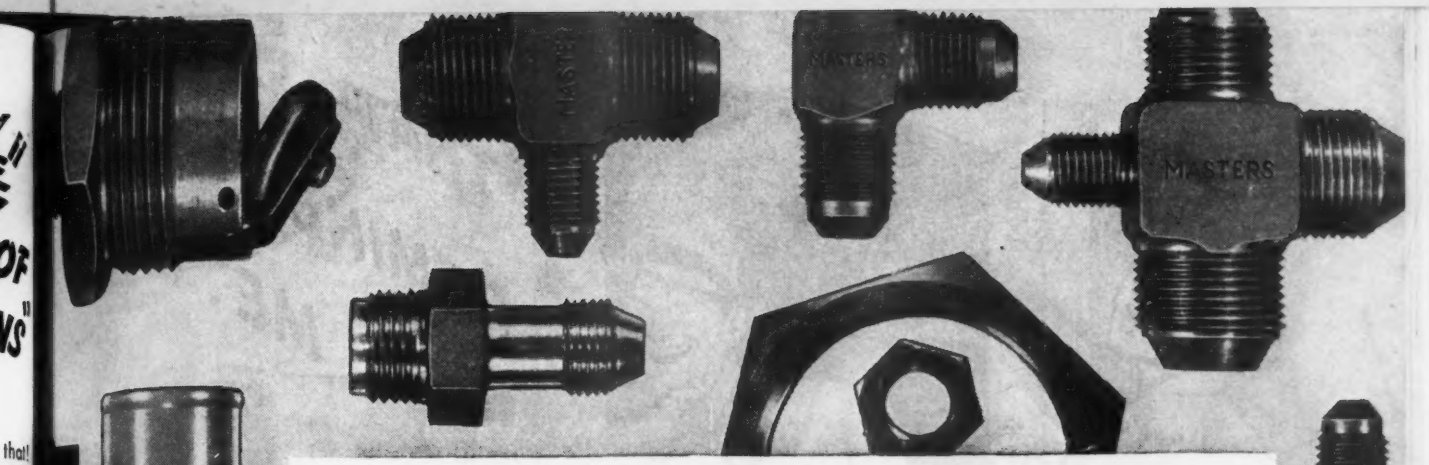
WHAT WE DON'T KNOW are the names of all the engineers and designers who, we feel sure, will be glad to have the complete illustrated story on "Spring-life," showing characteristics, construction, data charts, etc. Because clairvoyancy can't help us with this problem, why don't you send for your copy of this 44-page book today? It may help you solve many unusual engineering problems.

Remember one of our field engineers will be pleased to call on you and consult with you on your present or post-war problems. Although supplying our armed forces with all their demands, on time, is still our primary job, our engineering force is efficiently geared to assist you with your future considerations.

COOK ELECTRIC Company

"Spring-Life" Engineered Midget to Giant Size Bellows

2700 SOUTHPORT AVENUE · CHICAGO 14, ILLINOIS

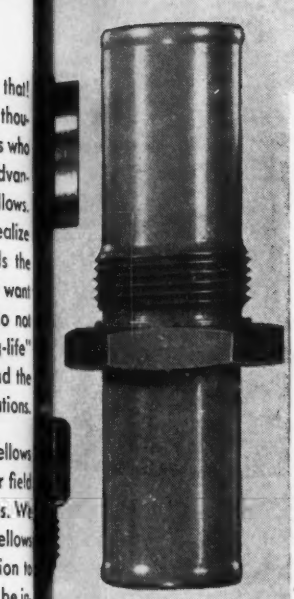


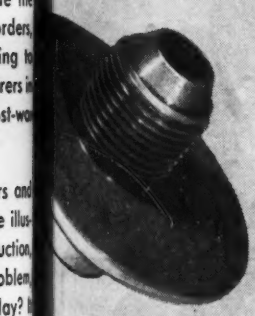
SHORT RUNS and LONG RUNS

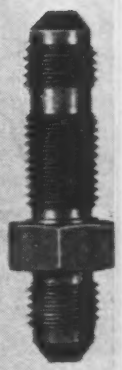
● Specializing in the manufacture of pipe, tube and hose fittings, for American and Allied fighting machines, Masters has accumulated equipment and staff of outstanding versatility.

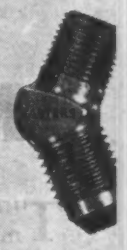
A great variety of parts in aluminum, brass, steel and other materials are milled, drilled, turned and threaded in our plant. Short runs and long runs of parts and accessories, ranging from photographic to railway, aircraft and marine equipment, fall right into the groove at Masters.

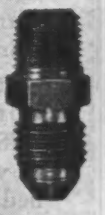
Skill, complete gaging, inspection equipment, and adequate engineering combine with economical manufacturing 'know how' to make Masters a good bet for your present and postwar manufacturing. Let our engineers help you.











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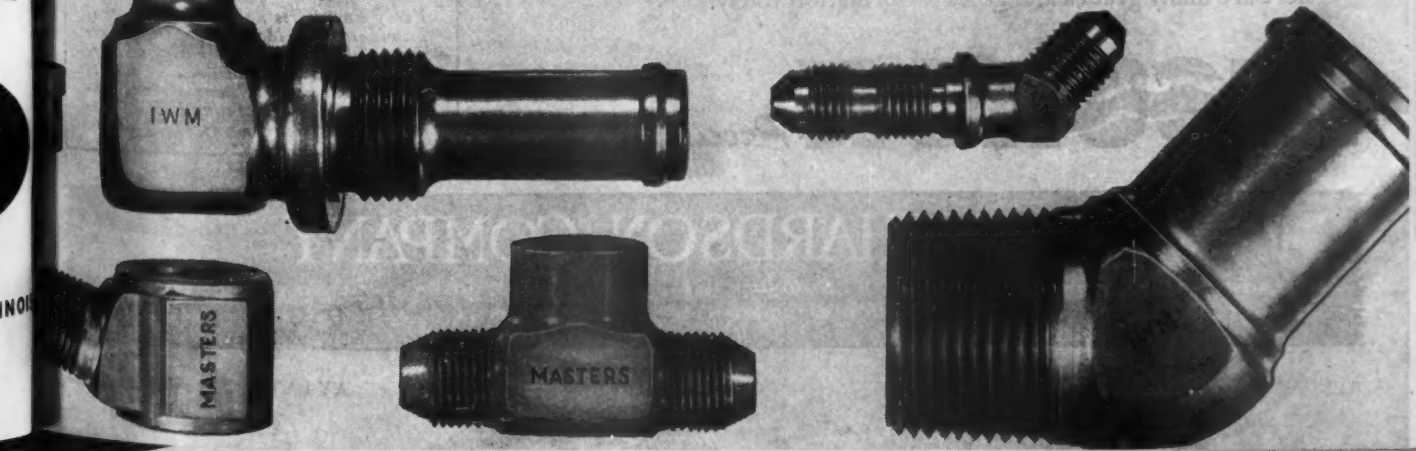
America's Most Versatile Fitting Factory



INSUROK HAS LOW MOISTURE ABSORPTION"

THE dangers of damage from moisture and corrosion are minimized when INSUROK is used. And, in addition, it has the stamina to absorb shock and to stand up under rough handling.

It is not strange, therefore, that both Molded and Laminated INSUROK are being widely used in war products—are being specified for use in many types of products for tomorrow.

There are many grades and types of Laminated and Molded INSUROK, with a wide range of chemical, electrical and mechanical characteristics. One or more types of INSUROK will meet practically every requirement.

Richardson Plasticians have had years of experience in working with designers and manufacturers. They will be glad to help you determine the grade best suited to your needs. Write for complete engineering information today.

Every day, parts and products made of Laminated or Molded INSUROK are successfully meeting all kinds of moisture and temperature conditions. Be sure to get the facts about this and other characteristics which are causing INSUROK to be specified for so many types of products.

INSUROK *Precision Plastics*

The RICHARDSON COMPANY

MELROSE PARK, ILL. NEW BRUNSWICK, N. J. FOUNDED 1868 INDIANAPOLIS 1, IND. LOCKLAND, CINCINNATI 15, OHIO
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A Mark of Quality that Your Customers Will Appreciate

Color styling will play a big part in civilian plane merchandising. The use of Berryloid Aircraft Finishes will give you an important advantage in achieving identification, distinction and consumer preference for your postwar plane.

Millions of gallons of Berryloid primers, pigmented dope and camouflage materials have been used on American and Canadian war planes. Fighter pilots and aviation technicians in every war theatre know the uniformly high quality and durability of Berryloid Aircraft Finishes. Their familiarity with these well-known finishes will continue to be a big influence in their postwar aviation purchases or recommendations.

Everybody knows and accepts Berryloid as one of the "leader products" in the aviation industry. It has held this position of leadership for more than 30 years. Include Berryloid Finishes as a quality feature in your new postwar plane. It will give you a definite competitive advantage.

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Paints · Varnishes · Enamels · Lacquers
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Leading Producers of Aviation Finishing Materials in War and Peace, for over 30 Years

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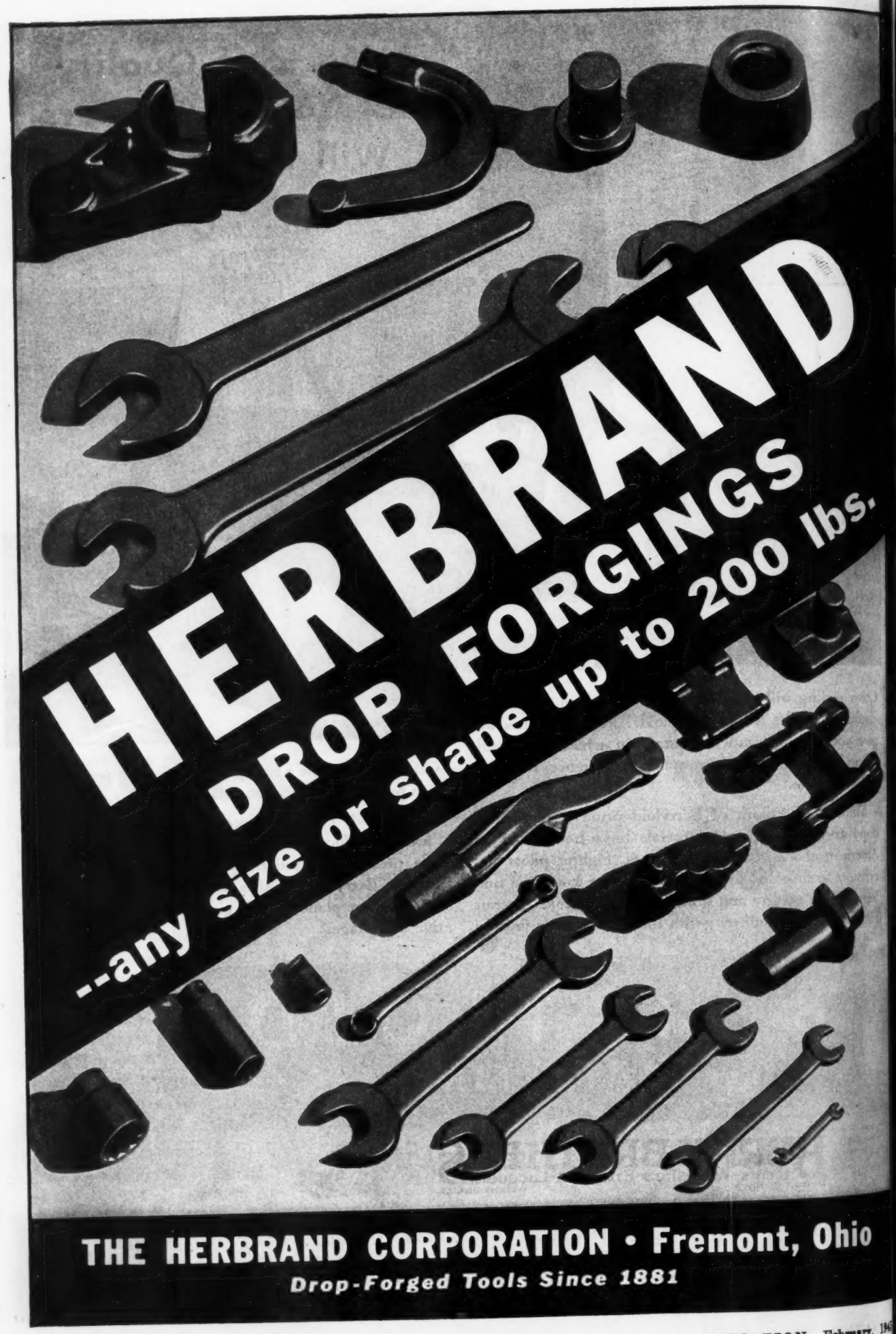
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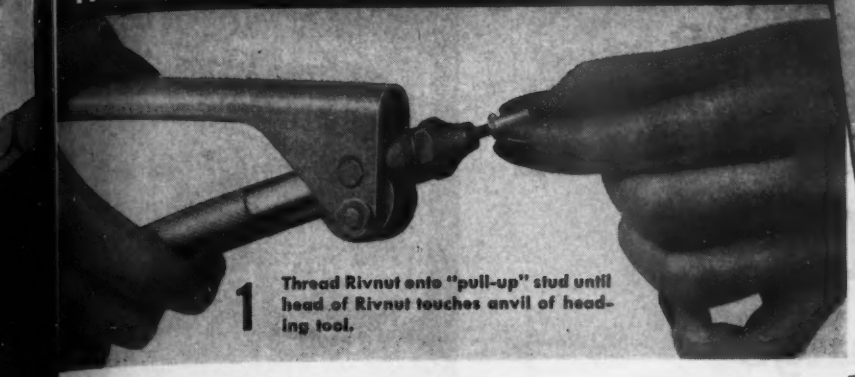
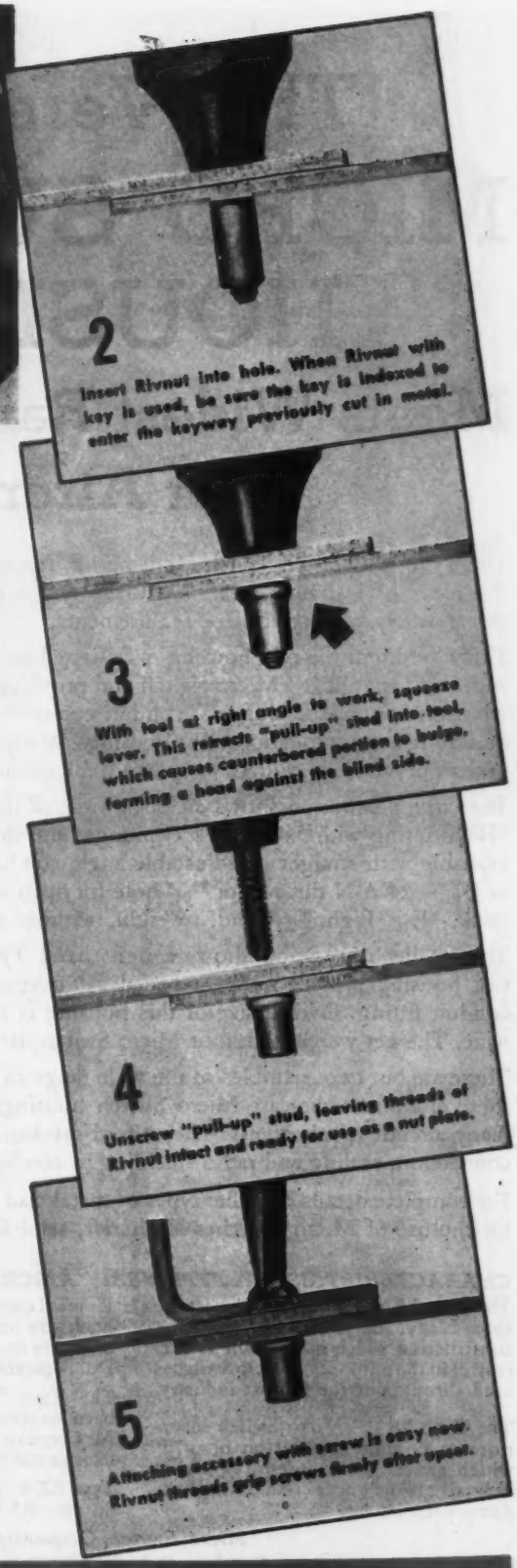
DROP FORGINGS
--any size or shape up to 200 lbs.
THE HERBRAND CORPORATION • Fremont, Ohio
Drop-Forged Tools Since 1881

HERE'S HOW RIVNUT WORKS



1 Thread Rivnut onto "pull-up" stud until head of Rivnut touches anvil of heading tool.



2 Insert Rivnut into hole. When Rivnut with key is used, be sure the key is indexed to enter the keyway previously cut in metal.

3 With tool at right angle to work, squeeze lever. This retracts "pull-up" stud into tool, which causes counterbored portion to bulge, forming a head against the blind side.

4 Unscrew "pull-up" stud, leaving threads of Rivnut intact and ready for use as a nut plate.

5 Attaching accessory with screw is easy now. Rivnut threads grip screws firmly after upset.

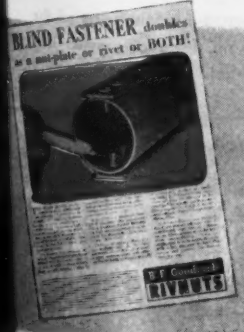
NEW RIVNUT MAKES TOUGH FASTENING PROBLEMS EASY!

Used as *Blind Rivet* . . . as *Nut Plate* for attachment... or both at once!

THE RIVNUT is a one-piece tubular rivet, counterbored and internally threaded. It is upset with an easily operated hand tool while working entirely from one side. A circumferential bulge forms on the blind side that is large enough to prevent its being pulled through metal or plastic even under conditions of eccentric load.

For either use—as a blind rivet or as a nut plate for attachment—the Rivnut has important advantages: One-piece design keeps cost down—makes installation so easy, even a blind man can do it. Rivnuts are light, strong, compact—ready for use as received. They have an unusually wide bearing surface, yet require a smaller hole than other blind fasteners. Keyed Rivnuts are available for use as nut plates.

Rivnuts are now made of both corrosion-resistant aluminum alloy and brass. In addition, a new *splined* Rivnut is available for use in wood or plastics. If special-purpose Rivnuts are needed for your particular application, our engineers will be glad to work up special designs for you. The B. F. Goodrich Company, Dept. 103, Akron, Ohio.



FREE . . . NEW "RIVNUT DATA" BOOKLET

Get the whole step-by-step story of Rivnut installation; facts on Rivnut types, sizes, grip-ranges, etc. Just write to The B. F. Goodrich Company, Department 103, Akron, Ohio.

B.F.Goodrich

RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

This Versatile MICRO SWITCH HOUSING

Meets Widest Range of Aircraft Uses

Type "H" Aluminum Die Cast Micro Switch Housing with cover removed.

Type "H" Housing showing easy access to Micro Switch.

The Type "H" Micro Switch Housing has incorporated the ideas of leading aircraft engineers and accurately meets widely varying airplane requirements.

This aluminum die-cast housing is designed to operate with the Type "R31" Micro Switch and provides a wide selection of actuator plungers, conduit connections and mounting accommodations. The housings are supplied in both rights and lefts, with or without ground connections.

The large illustration shows an open view of the Type "H" housing with $\frac{3}{8}$" overtravel plunger and mounting ears. These are available with straight or adjustable angle conduit fittings with $\frac{3}{4}$"—20 or $1\frac{1}{16}$"—24 A-N threads; or $\frac{29}{64}$" hole for open wiring. Overall size is 1" thick, $3\frac{15}{16}$" high, $\frac{25}{32}$" wide. Weight, without switch, is .227 pounds.

The smaller illustration shows a right hand Type "H" aluminum die cast housing provided with a sealed $\frac{3}{8}$" overtravel plunger and angle conduit fitting. Overall size of this housing is 1" thick, 3" high, $3\frac{11}{32}$" wide. The net weight, without Micro Switch, is .272 pounds.

These are but two examples of the wide range of different ways in which these aluminum die-cast Micro Switch housings can be secured to fit many aircraft requirements. They afford mechanical protection, conduit connection, sealing and radio shielding as conditions may require.

For complete details on other types of metal clad housings and actuators for the use of Micro Switches in aircraft, send for our Catalog No. 70.

CHARACTERISTICS OF TYPE "R31" AIRCRAFT MICRO SWITCH

The Type "R31" Micro Switch uses the three-bladed beryllium copper spring construction which has proven so successful in the millions of Micro Switches used throughout the aircraft industry.

The Type "R31" Micro Switch incorporates contact separation of .070" which satisfactorily interrupts highly inductive loads under conditions of extreme altitude.

Knurled contact surfaces insure positive operation on extremely small loads and minimize transfer of contact material on D.C. operation.

The Type "R31" Micro Switch has been accepted as standard by the Army Air Corps and the Navy Bureau of Aeronautics and is stocked at all Air Depots.

Type BZ-R31 approved under AN Specification AN3910.

FEATURES OF THE TYPE "H" MICRO SWITCH HOUSING

1

Basic Micro Switch Units are easily replaced, since they are carried on a pair of accurately fitting pins.

2

Entire assembly may be sealed against entry of water, dust, oil, etc., by means of a synthetic rubber seal placed on the plunger. See illustration.

3

Gasket and cover are secured with flat head cross slotted screws.

4

A ground connection from the switch to the case may be provided inside of the case. Ample wiring space is provided.

5

Housings and actuators become parts of the planes and require no deviation permit. They are built for ready field replacement.

Micro Switch Corporation, Freeport, Illinois

Branches: 43 E. Ohio St., Chicago (11) • 4900 Euclid Ave., Cleveland (3) • 11 Park Pl., New York City (7) • 1709 W. 8th St., Los Angeles (14) • Sales & Engineering Offices: Boston • Hartford Portland, Ore. • Dallas, Tex.

LET'S ALL BACK THE ATTACK . . . BUY EXTRA WAR BONDS

The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation

MICRO MS SWITCH

Made Only By Micro Switch Corporation . . . Freeport, Illinois, U.S.A.

Cylinder life multiplied by 5

Cylinder life that is multiplied by 5 is the experience of a large city bus company who made the comparison between PORUS-KROME cylinders and ordinary cylinders in the same engines.

The reason that cylinders last longer when they have been treated with PORUS-KROME, applied by the Van der Horst process, is that it resists wear and corrosion better than any other known cylinder material.

PORUS-KROME is pure, hard chromium which has been processed so that there are myriads of tiny pores and channels in its surface. These pores and channels serve as reservoirs which hold lubricating oil and feed it back to the cylinder surface as needed. Better lubrication, plus the fact that chromium is so much harder than iron or steel, reduces wear to a minimum. Field tests have shown that PORUS-KROME multiplies cylinder life from four to twenty times . . . depending on the size and type of engine.

If you are a builder or a user of engines . . . gasoline or Diesel . . . you will profit by specifying PORUS-KROME. Write for complete information today.

PORUS - KROME

Good for the Life of your Engines

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The Truck With a

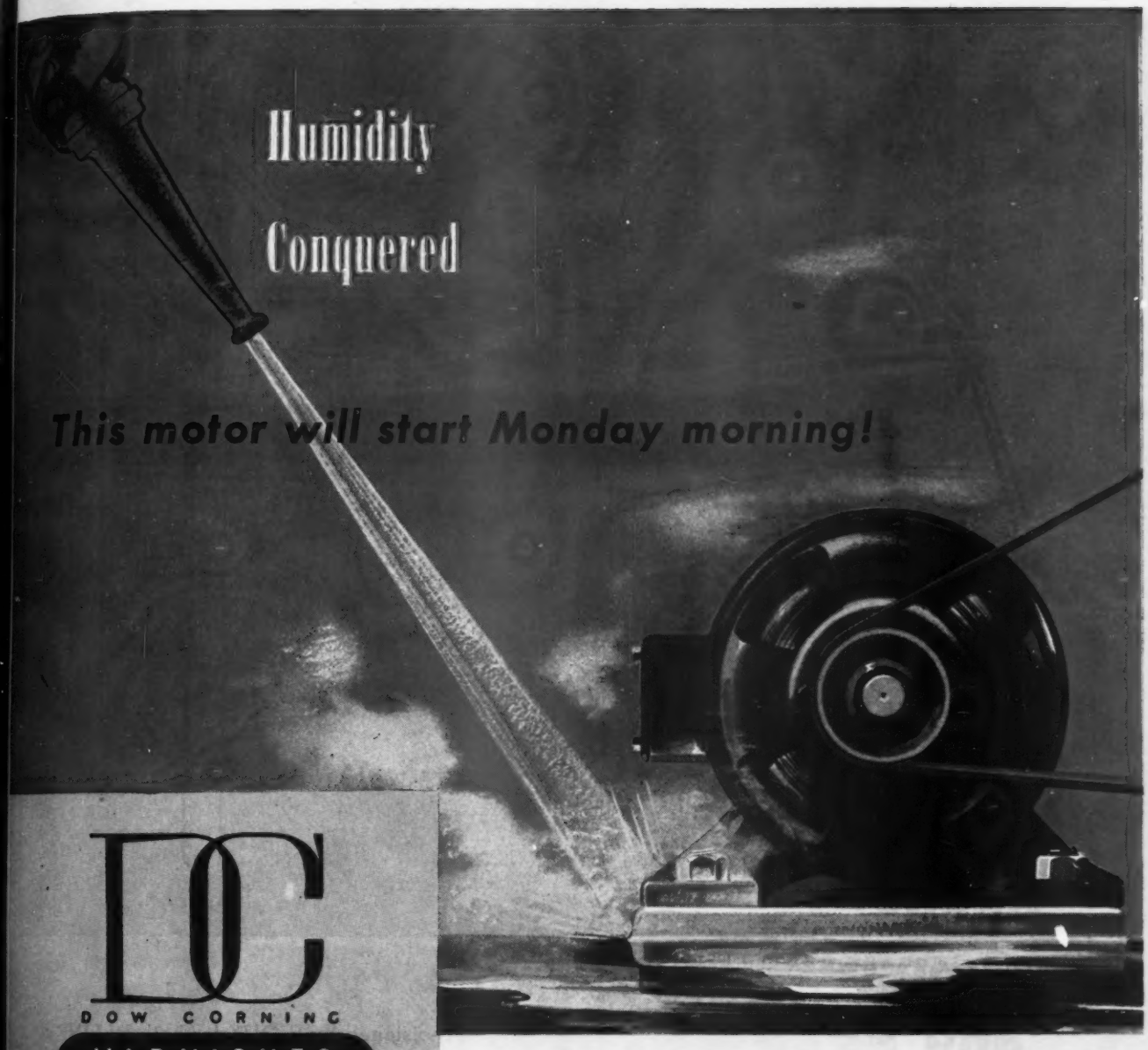
$50,000,000.00 ENDORSEMENT

FWD's MODEL HAR

A truly great truck — the FWD Model HAR—a truck that in just four years has won the endorsement of motor truck users to a total of $50,000,000 in purchases of this single model—a truck that has achieved the phenomenal record of $50,000,000 in manufacturing experience in the comparatively brief span of 48 months.

Rated at 20,000 lbs. gross, the Model HAR embodies the highest development of the four-wheel-drive principle, pioneered and sponsored by FWD since 1910. Truck operators know that the true four-wheel-drive principle as applied in FWD's gives these trucks a basic mechanical advantage—qualifies them to get through regardless of road or weather—to go with greater safety — to perform year after year at lowest cost per ton mile — to conserve war-precious gas-oil-tires-replacements. When the call is for rugged, dependable trucks to provide vitally important motor transport, your confidence is well placed in FWD's.

THE FOUR WHEEL DRIVE AUTO CO.
Clintonville, Wisconsin
Canadian Factory: KITCHENER, ONT.



DOW CORNING
VARNISHES

HIGH TEMPERATURE SILICONE INSULATION

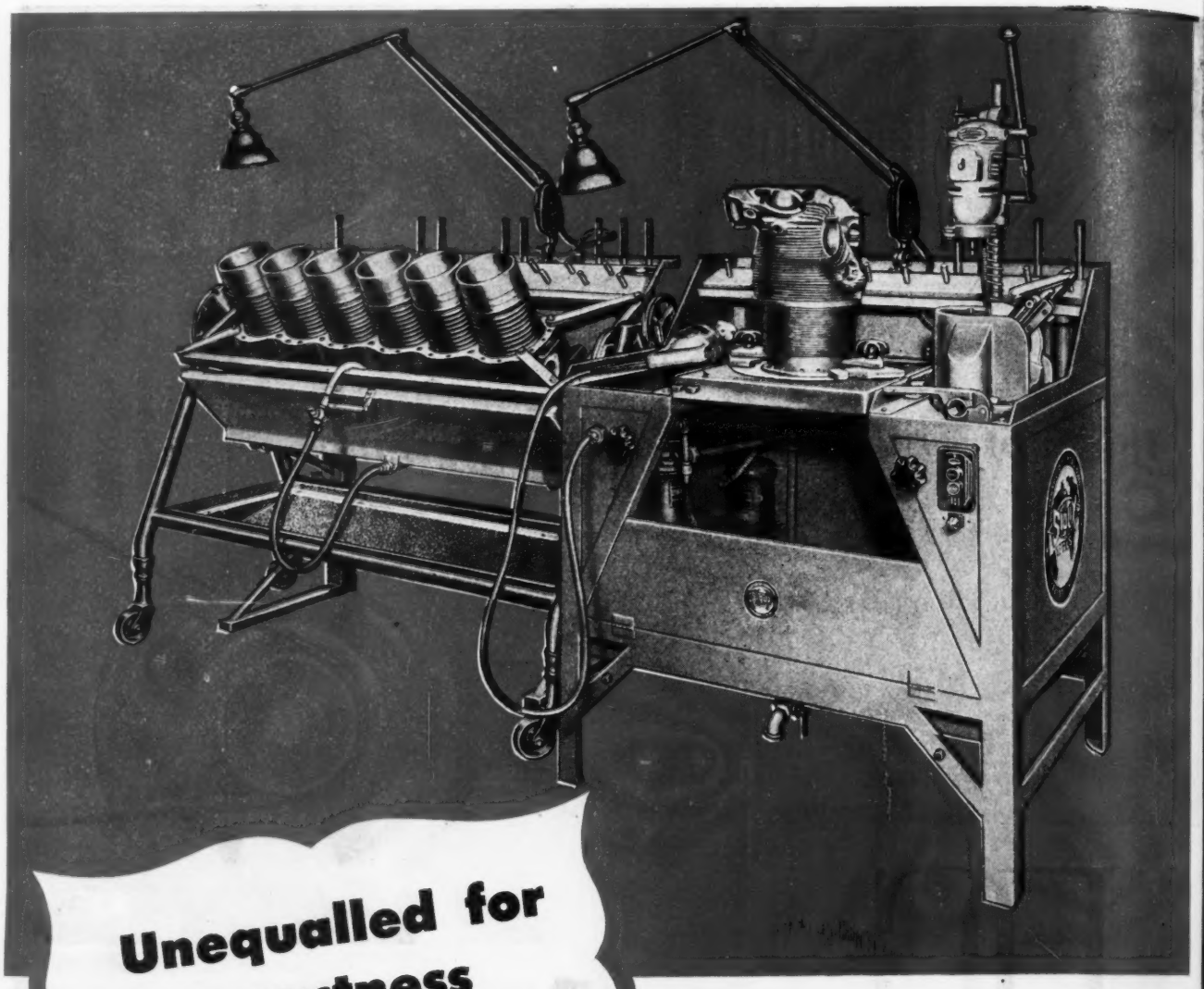
Humidity, the primary reason for failure of motors and other electrical equipment, is conquered by DC Silicone Varnishes. Even under extreme conditions of condensation, severe overloads or idleness in moist locations, DC insulated equipment starts and runs at full load.

High temperature silicone insulation was first made possible by DC Varnishes. These new heat stable resins are natural complements to the inorganic spacing materials—mica, Fiberglas and asbestos. Dow Corning Silicone Varnishes provide bonding and filling dielectrics which are highly resistant to heat, moisture, oil and chemicals.

DOW CORNING 993 . . . available in commercial quantities, is a heat curing, high temperature stable silicone varnish for impregnating motor stators, transformer coils and other electrical equipment; for varnishing Fiberglas or asbestos served wire; for varnishing Fiberglas and asbestos electrical insulating cloths, tapes, tying cords and sleeving; for bonding Fiberglas and mica combinations.

DOW CORNING CORPORATION
BOX 592, MIDLAND, MICHIGAN

Dow Corning



Unequalled for compactness and efficiency

Precisioned by SIOUX for both IN-LINE and RADIAL Aircraft motor work, this complete unit enables the operator to speed up with precision in either production or maintenance.

Everything within easy reach.

It wet grinds both exhaust and intake valve seats without removing cylinder.

Wheel loading and scratching is eliminated and wheel dressing is reduced to a minimum.

Write at once for full details.

SIOUX AIRCRAFT wet valve seat GRINDING MACHINE

FOR INLINE AND RADIAL MOTORS

STANDARD THE WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

What will an Ex-Pilot expect of a

PEACETIME STEERING WHEEL?

Certainly no less than the qualities and serviceability of the finest Lumarith* Plastics for war planes.

Looking ahead to motor cars and planes of tomorrow? Give a thought to that one part handled most—the steering wheel. Plastics come to mind first of course—probably Lumarith, because this versatile Celanese plastic has been so thoroughly proven in war and peace.

ON THE ONE HAND

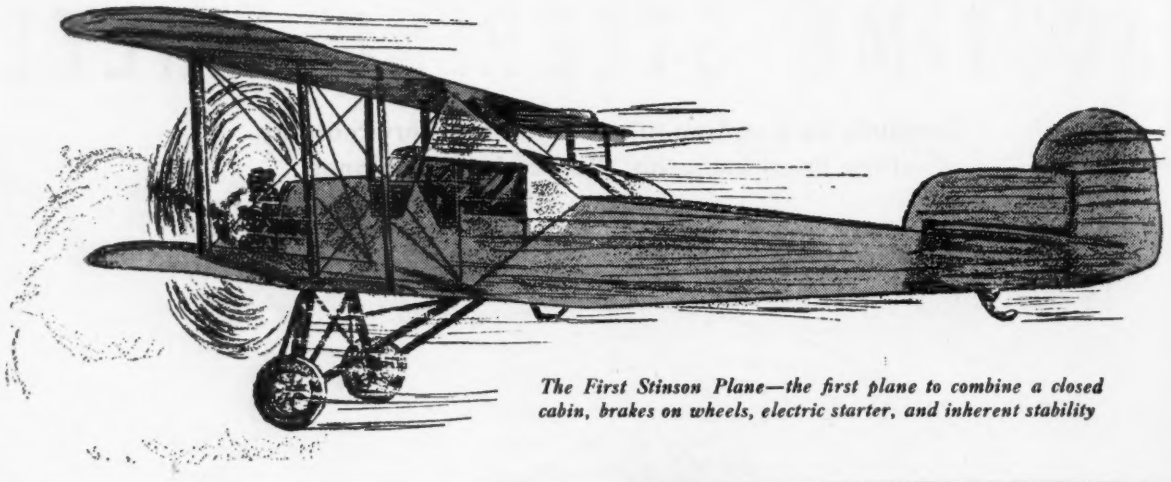
Dimensional and Surface Stability—Lumarith, injection molded over metal, is unusually tough even at temperature extremes; highly resistant to moisture, aging, warping. Elongation, so important, is more than adequate to handle differences in expansion coefficients between plastics and metal cores. The chip-proof surface actually is self-polishing. Colors are rich, stable.

AND ON THE OTHER

Lightness and "Feel"—Formulations of Lumarith C.A., Lumarith X, and Lumarith E. C. are lightweight without sacrifice of flexural strength. Molded parts are inviting to the touch despite the weather.

Plastics will be bigger than ever in post-war automotive production. Let us help you plan projected improvements. We have accumulated data on a wide range of Lumarith formulations for all types and grades of automotive plastic applications from steering wheels to dash crystals. *Celanese Plastics Corporation,* The First Name in Plastics, a Division of the Celanese Corporation of America, 180 Madison Avenue, New York 16.

*Reg. U. S. Pat. Off.



The First Stinson Plane—the first plane to combine a closed cabin, brakes on wheels, electric starter, and inherent stability

Stinson "firsts"— before, during, and after

THE NAME "STINSON" has been associated with personal plane aviation leadership ever since that name was first given to an airplane, back in 1926.

When this 1926 Stinson took to the air, it carried aloft an impressive number of "firsts."

DESIGN "FIRSTS"

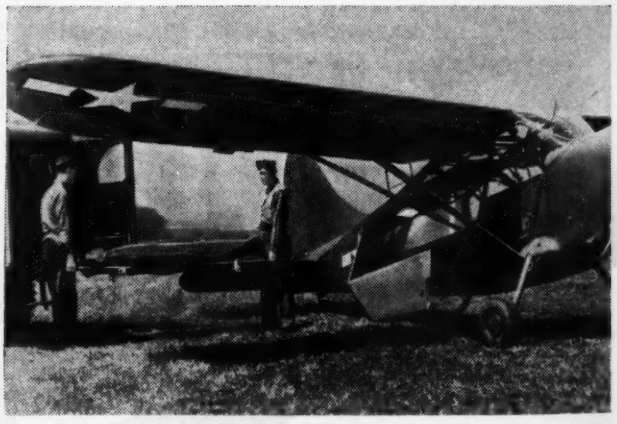
Stinson was the first plane to combine the following features:

- An enclosed cabin
- The safety afforded by brakes on landing wheels
- The convenience of an electric starter
- The comfort of a cabin heater

PREWAR PERFORMANCE "FIRSTS"

During the past 19 years Stinson has piled up an impressive number of performance "firsts" in the fields of commercial and personal flying:

- A Stinson plane carried the first air mail in China
- It carried the first government mail in Mexico and in the Philippines
- Made the first flight from Detroit to Tokyo, and from New York to Be... da
- Inaugurated the world's first air-mail pick-up service
- First explored the Greenland route to Europe, the present-day route of the North Atlantic Air Ferry.



Stinson "Flying Jeeps" serve the armed forces as flying ambulances, observation and liaison planes, under the toughest flying conditions.

STINSON "FIRSTS" DURING THE WAR

Stinson's main wartime job has been the manufacture of liaison and training planes for our fighting forces—the Stinson Sentinel, or "Flying Jeep," the Stinson Vigilant L-1, and the Stinson Reliant AT-19.

A Stinson Sentinel, hopping from the deck of a carrier, was the first American plane to land on Jap-infested Pelelieu Island, while U. S. Marines were slugging it out for the beachhead . . . only one typical instance of many similar occurrences when Stinson planes took part in invasions.

"Out in front" of the front, these sturdy little Stinson "Flying Jeeps" are serving as the "eyes" of the armed forces, as flying ambulances, and on important liaison duty.

The Stinson Voyager is the No. 1 plane of the Civil Air Patrol. It has the distinction of carrying out 65 per cent of the Patrol's wartime operations, which have included the sinking of a number of submarines and the saving of hundreds of lives.

The Stinson Reliant AT-19 has been widely used as a navigational trainer by the British. And almost every airline in the United States uses Stinson planes to train and check their pilots.

The Stinson "Flying Jeep"—wartime successor to the peacetime Voyager—has demonstrated its stamina and utility as the No. 1 liaison plane of the Army, Navy, and Marine Corps all over the world.

THE STINSON VOYAGER 125 . . .
the No. 1 Plane for Postwar Personal Flying

The first postwar personal plane designed by Stinson—the Voyager 125—combines the *safety* and *reliability* of the prewar Voyagers with the *toughness* and *utility* of the Stinson "Flying Jeep."

Here are some of the high lights of this quality personal plane—

Carries three passengers in addition to pilot.

Maximum speed of 123 m.p.h. at sea level.

Range of 470 miles without refueling.

Service ceiling 14,000 ft.

545-ft. take-off run; 265-ft. landing roll—with flaps down.

Powered by 125 h.p. engine.

Cruising speed of 112 m.p.h. at 83 per cent power.

Rate of climb—750 ft. per minute at sea level.

Parts for Stinson Planes. We are now making a full line of parts for the thousands of Stinson planes now in service. Order spare parts for your Stinson from your local Stinson distributor or direct from the factory.

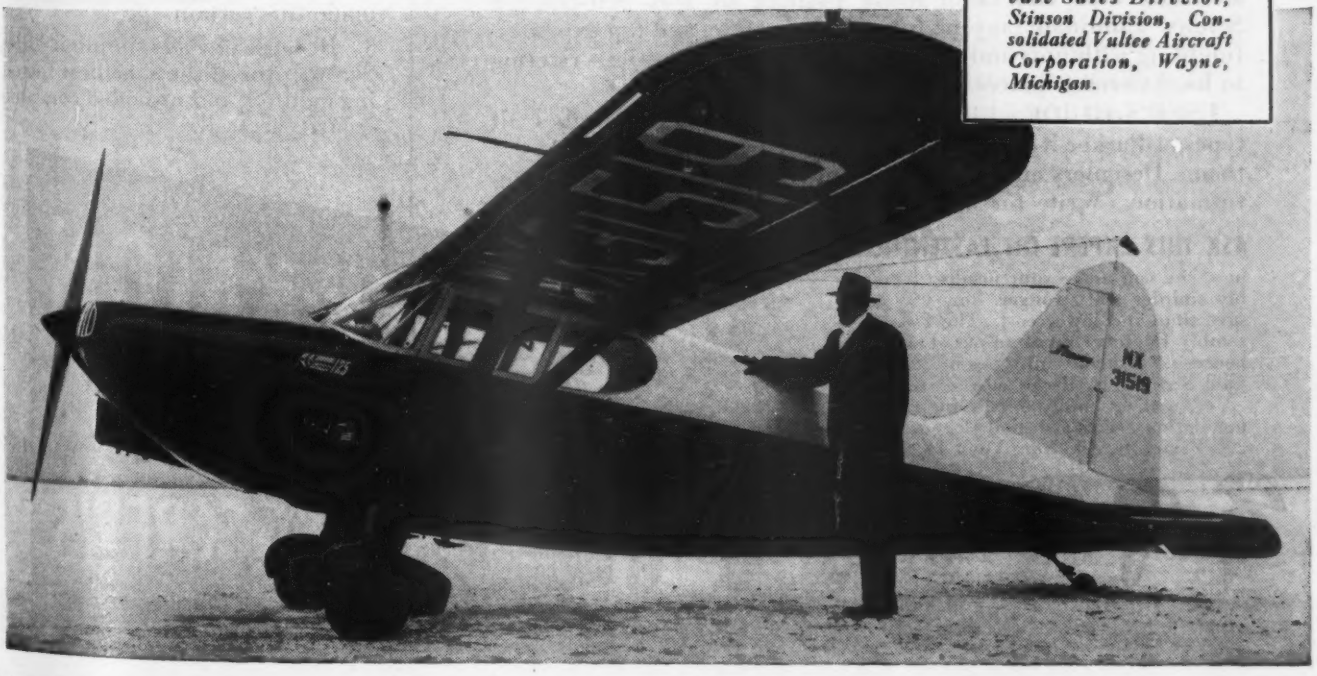
Stinson

The Aircraft Standard of the World

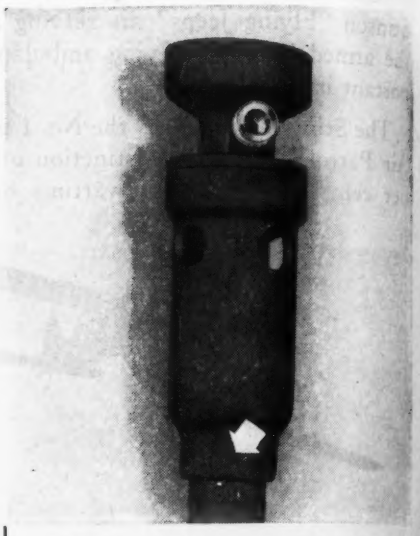
Division of Consolidated Vultee Aircraft Corporation, Wayne, Michigan

The Stinson Voyager 125 is the forerunner of a distinguished line of planes for personal flying that Stinson will make as soon as war conditions permit.

We welcome inquiries about the Voyager 125 and about Stinson's postwar plans. Write to Private Sales Director, Stinson Division, Consolidated Vultee Aircraft Corporation, Wayne, Michigan.



CLEAR OUT THE "Fastening Bugs" BEFORE YOU SET UP FOR PEACETIME PRODUCTS



Specify the SHORT CUT FASTENING METHOD and avoid later changes, expense, delays

Don't wait until you resume manufacture of your peacetime product to find out that needless tapping, needless inserts in plastics, or other fastening "bugs" are slowing down assemblies and running up your costs.

Check up *now*, while your plans are still in process. Choose fastenings as carefully as you settle any other factor of design. Make sure you are using the *short cut fastening method* – Parker-Kalon Self-tapping Screws – wherever possible.

Give your product the advantage of the 30% to 50% saving in assembly time and labor made possible by P-K Self-tapping Screws. Eliminate tapping for machine screws and tap expense – fumbling with nuts and bolts – costly inserts in plastics – riveting in hard-to-reach places.

USER'S GUIDE – FREE! P-K "Users' Guide" describes all types of Parker-Kalon Self-tapping Screws and tells where to use them. Designers and assembly planners need this important information. Write for a copy.

ASK THIS EXPERT ON FASTENINGS

how you can make your product assembly simpler and stronger, how you can save time and lower cost. The P-K Assembly Engineer gives unbiased advice, because P-K makes all types of Self-tapping Screws. He'll call at your request ... or, mail assembly details for recommendations. Parker-Kalon Corporation, 208 Varick Street, New York 14, N. Y.

Will needless tapping and faulty "line-up" slow your assembly?

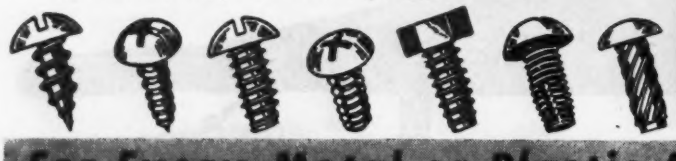
Here's how Pyrene planned ahead and licked these "bugs"

This well-known maker of fire-fighting equipment, checked fastenings carefully when designing their Phomaire extinguisher. Two fastenings were needed to attach a steel cage to a steel nozzle tube permanently, and P-K Type "U" Screws were chosen for three reasons...

1. If machine screws were used, tapping would take extra time, and tap breakage would be high because the holes do not always line up exactly. This would also cause difficulty in driving machine screws. Type "U" Screws, however, can be driven into plain drilled holes.

2. A tamper-proof fastening was desired, one that discouraged disassembly. P-K Type "U" Screws made this certain.

3. Because of their simplicity, P-K Screws proved the speediest fastening method, and provided complete security as well.



PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

For Every Metal or Plastic Assembly

For more Speed in the "Tight Spots"

Photo courtesy Republic Aviation Corporation

—Use Flexible, Versatile Snap-on "Combinations"

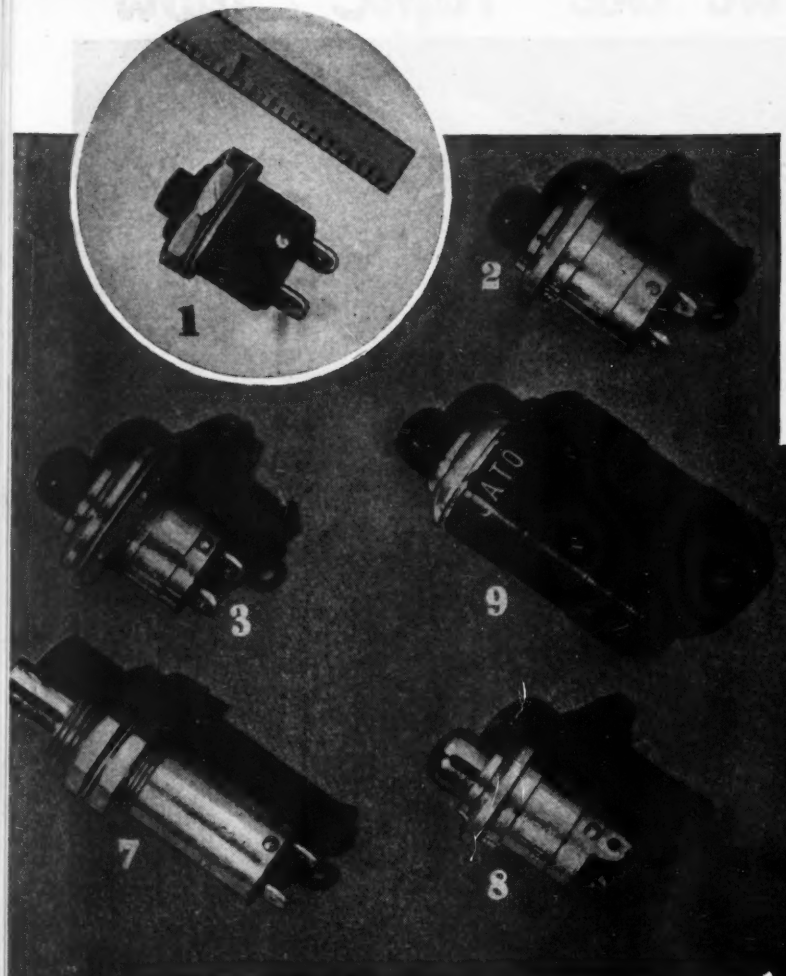
Remember back when "tight spots" were roundly damned as "bad design". Today they are the accepted penalty of *good design* . . . the unavoidable result of packing incredibly high performance into sharply restricted dimensions.

And for the toughest tight spots there are modern Snap-on tools . . . versatile "combinations" that reach into deepest pockets, grip hidden nuts securely, turn them easily, swiftly, solidly. The instant adaptability of Snap-on sockets, handles and ratchets, multiply the range of a compact Snap-on kit into hundreds of speed tools for specialized applications. *And frequently save the cost of specially designed one-job tools!*

Snap-on nation-wide service, with 38 factory branches in key production centers, provides right-at-hand personal tool service to industry everywhere. Write for Snap-on catalog and address of nearest branch.

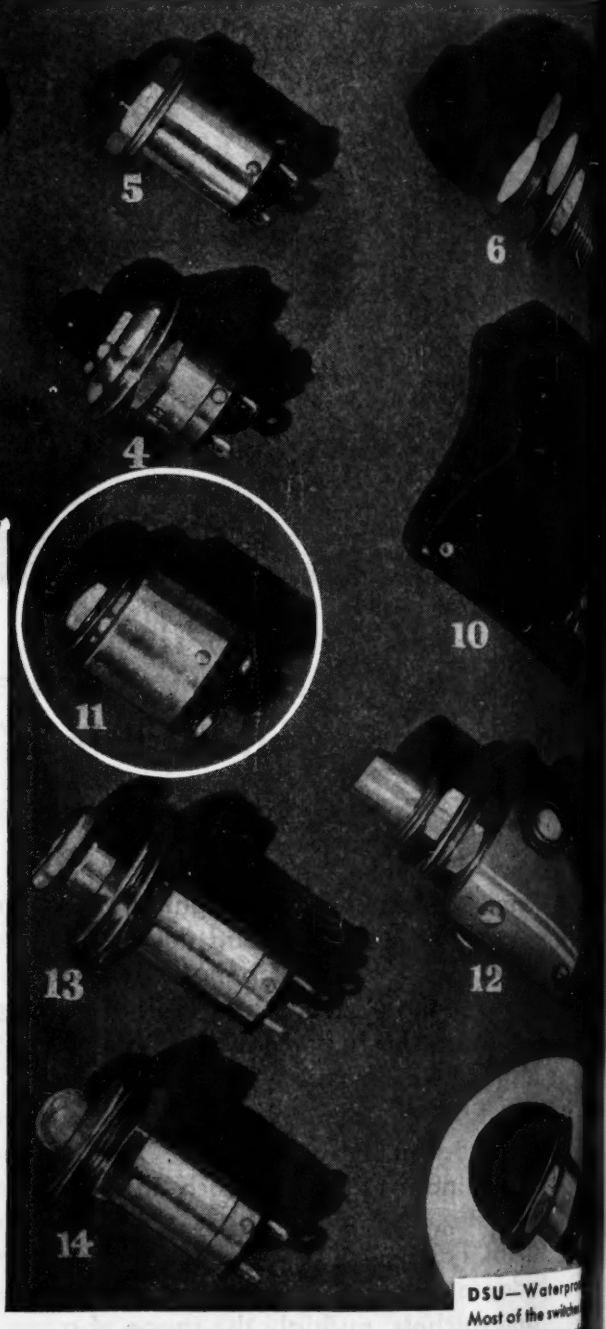
SNAP-ON TOOLS CORPORATION
8020-B 28th AVENUE KENOSHA, WISCONSIN

A SHORT TIME AGO, EACH WAS A *Special*



NOW EACH IS PART OF OUR LINE OF AIRCRAFT SWITCHES

We will be glad to send information on these and other switches in our complete line. Blueprints are also available. If you have a switch problem remember that each switch here at one time represented what was a special problem to somebody else.



TECHNICAL DATA IN BRIEF

All Switches Altitude, Heat and Cold Tested

+**1. **JUNIOR**—Single hole mounting. Overall length 1"—diameter 5/8".

+**2. **DSO**—Large flange type mounted from front of panel.

+**3. **DSP**—Large flange type with thread mounting.

+**4. **DSU**—Small flange type with thread mounting.

+**5. **DSW**—Small barrel single hole mounting.

+**6. **LBT**—Waterproofed. 7/16" total travel, 7/32" overtravel. Long thread for positioning.

+**7. **LBDS**—Small barrel. 7/16" total travel, 7/32" overtravel. Long thread for positioning.

8. **KSGOX-A**—Microphone switch. Grounds two circuits to case of switch. Normally open or closed.

+**9. **DSU-AS**—DSU switch screwed into bakelite sleeve. Furnished complete.

+**10. **TDS**—Bakelite housed trigger switch. Lever action.

11. **HDSW**—35 ampere inductive load at 30 volts. Furnished normally open or closed.

+12. **HVMDT**—Heavy duty switch. 35 to 50 ampere inductive at 30 volts. 7/16" total travel.

13. **SCDSP-L**—Contains easily removed light bulb in cap. Main contacts rated at 16 amperes inductive and momentary contact rated at 3 amperes. All contacts normally open.

14. **RLDSP**—Push on—push off type switch. 5 amperes at 30 volts.

Note that bakelite plungers can be furnished in two lengths.

**RATING—15 amperes, 30 volts at 50,000' altitude.
All ratings D.C., Inductive Load.

\+ Can be furnished normally open, closed, 2 circuit or single pole double throw.

All switches double break—heavy silver contacts

DSU—Waterpro
Most of the switche
can be waterpro

ROBERT HETHERINGTON & SON

SHARON HILL, PA.

ESTABLISHED 1937

Technicians of the Harvey Machine Co., Inc., Aircraft Division, work as a team with the engineers of America's aircraft manufacturers in the development and production of an extremely large list of products.

Harvey precision skill and vast production facilities are available to you in fields of aircraft manufacture.

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MAJOR AIRCRAFT ASSEMBLIES	AIR CARGO EQUIPMENT	GUN MOUNTS
WINGS—FUSELAGE SECTIONS	WING PANELS	AMMUNITION BOOSTERS
OIL AND GASOLINE TANKS	ENGINE COWLINGS	ARMAMENT
CONTROL SURFACES	NACELLES	AMMUNITION BOXES AND CHUTES
SPEED-RINGS	AUTOMATIC SCREW MACHINE PRODUCTS	ELECTRONIC DEVICES

Your development and production inquiries are cordially invited

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6200 AVALON BOULEVARD
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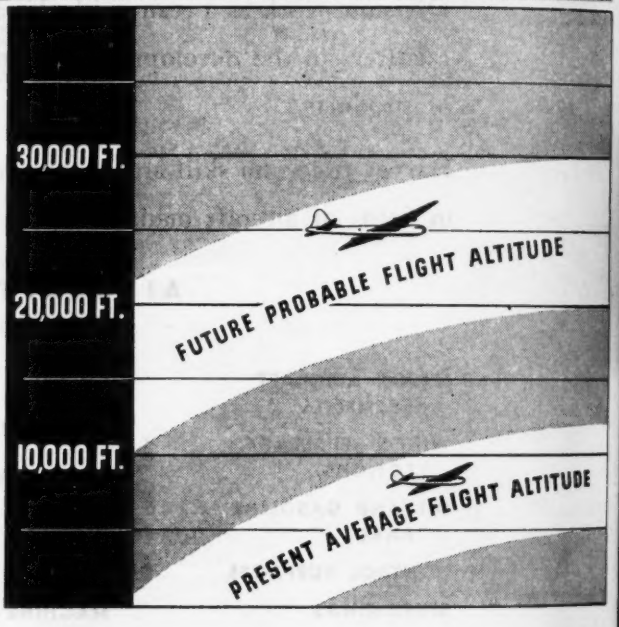
Plants Los Angeles and Long Beach

MANUFACTURERS OF AIRCRAFT PARTS SINCE 1917
ARMAMENT · AIRCRAFT COMPONENTS · ELECTRONICS · AIR CARGO

The B-29 forecasts a new kind of air travel



Its AiResearch Pressurized Cabin Controls prove substratosphere flight is safe—and comfortable

ONLY YESTERDAY the substratosphere was "no-man's land." To travel its thin, freezing air, men had to wear bulky, electrically-heated clothing—oxygen masks.

The Boeing B-29 is changing all that. *Pressurized Cabins* enable the Superforts to fly 30,000 feet, and higher, with complete safety and comfort for those inside.

AiResearch's part has been the development of air pressure controls . . . devices that keep "high-altitudes" *outside* the cabin, seal a comfortable "low-altitude" *inside* the plane at all times.

In peacetime, you will fly in similar AiResearch comfort-protected cabins. They will help lift commercial flying to faster, smoother, high-up levels. There will be no air pressure changes to cause headaches, dizziness and ear-popping. You'll enjoy warm air or cool, as you like it, in a cabin free of smoke and odor.

Yes, *a new kind of air travel* is ahead. Count on AiResearch to help create it . . . and to develop new devices for your greater comfort on the ground, as well. AiResearch Manufacturing Co., Los Angeles, Phoenix.

ARMY E NAVY

AiResearch
DIVISION OF
THE GARRETT CORPORATION

Superfortresses carry AiResearch Cabin Pressure Regulating Systems • Engine Oil Cooling Systems • Engine Air Intercooling Systems • Supercharger Aftercooling Systems • Automatic Exit Flap Control Systems • Temperature Control Systems

HAPPY LANDINGS FOR THE MIGHTY B-29...

Barco Brake Line Assemblies are giving consistently high performance on the Boeing B-29 Super-fortresses. Through responsive movement, Barco guards the vital fluid-conveying pipes from vibration and shock, gives flexibility to brake, and retracting mechanism hydraulic lines. Even the oxygen rebreather system in the turrets is protected by Barco. The proven safety value and low maintenance cost of Barco Flexible Joints (winterized for service conditions) have led to their use on many other types of military and commercial aircraft.

Write us about our 3000-pound pressure Swivel Joint for aircraft cylinders and other applications

BARCO

Manufacturing Company, Not Inc., *Aircraft Products Division*
1824 Winnemac Avenue, Chicago 40, Illinois
In Canada: The Holden Co., Ltd., Montreal, Canada

FLEXIBLE JOINTS

Not just a swivel joint . . . but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

"MOVE IN EVERY DIRECTION"

The Free Enterprise System Is the Salvation of American Business

HERE'S WHAT YOU CALL A REALLY GOOD IDEA

. . . and you ought to be able to think of one just as good!

THE LAPOINTE SHOCK RING JIMMY came to us without a name. It was merely an idea about how to meet a great need in servicing two popular makes of light planes. From its first crude form, we developed it into a handy, foolproof tool. Today it is in enormous demand.

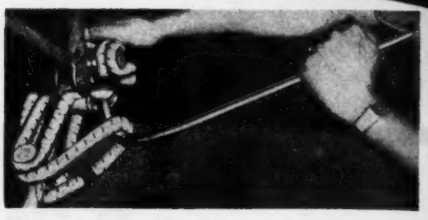
Now we'd like to turn our engineering and production skills to other servicing problems. You can help us do this . . . and earn money for yourself.

HERE'S ALL YOU HAVE TO DO

Think of some servicing problem like shock ring installation, that should be answered by some new device. Write us a letter, describing the problem. If we can solve it, and put our solution into production, we will send you a $500 check for telling us about the problem. (Of course, the first person to suggest the problem will be the only one considered on any single matter.)

Better yet, if you yourself have devised, or can devise some method of meeting a servicing problem, let us know what it is. If we decide to develop your idea and put it into production, we will make arrangements with you on either an outright purchase or royalty basis — as we have done with the man who suggested the Jimmy. (He gets a set figure for every Shock Ring Jimmy sold.)

Give complete details, such as the make and model of ship you are writing about. Include rough sketches, if possible. Why not sit down tonight, remembering all the servicing difficulties you've ever experienced, and write us that letter?!



HOW IT WORKS. Slip end of LaPointe Jimmy handle through shock ring, drop Jimmy's swivel head in place, then push or pull handle up and over.

WHAT HAPPENS. Shock ring easily slides down handle and over head, without cutting or fraying. Ring is on without twist. Jimmy pops off, ready for next job.

CLEARS TAYLORCRAFT dash. Other photos show Jimmy in use on Piper Cub. This shows how Jimmy works as easily and quickly on Taylorcraft.

THESE ARE DISTRIBUTORS OF THE JIMMY:

Air Associates, Inc.
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LaPointe
ENGINEERING COMPANY
UNIONVILLE, CONNECTICUT
Manufacturers of Precision Tools and Aircraft Accessories

PUSH BUTTON BRAKES at the *Speed of Sound*

Operated by a push-button on the pilot's control wheel, two 1¼ hp electric actuating units open "dive brakes" on P-38 wings, to give maximum maneuverability even at speeds approaching that of sound. The flaps do not materially slow the plane in lightning-like dives but help control it—to lick the phenomenon called compressibility. The action of the flaps extends the range of safe flying speed with fixed wing surfaces.

Designed from scratch by Electrical Engineering & Mfg. Corp., the actuators must insure unfailing and uniform-operation in the space of seconds, and meet stiff weight and size specifications. The units must also fit the wing panels of current P-38's as well as earlier models now in combat zones, in either case without requiring major structural modifications.

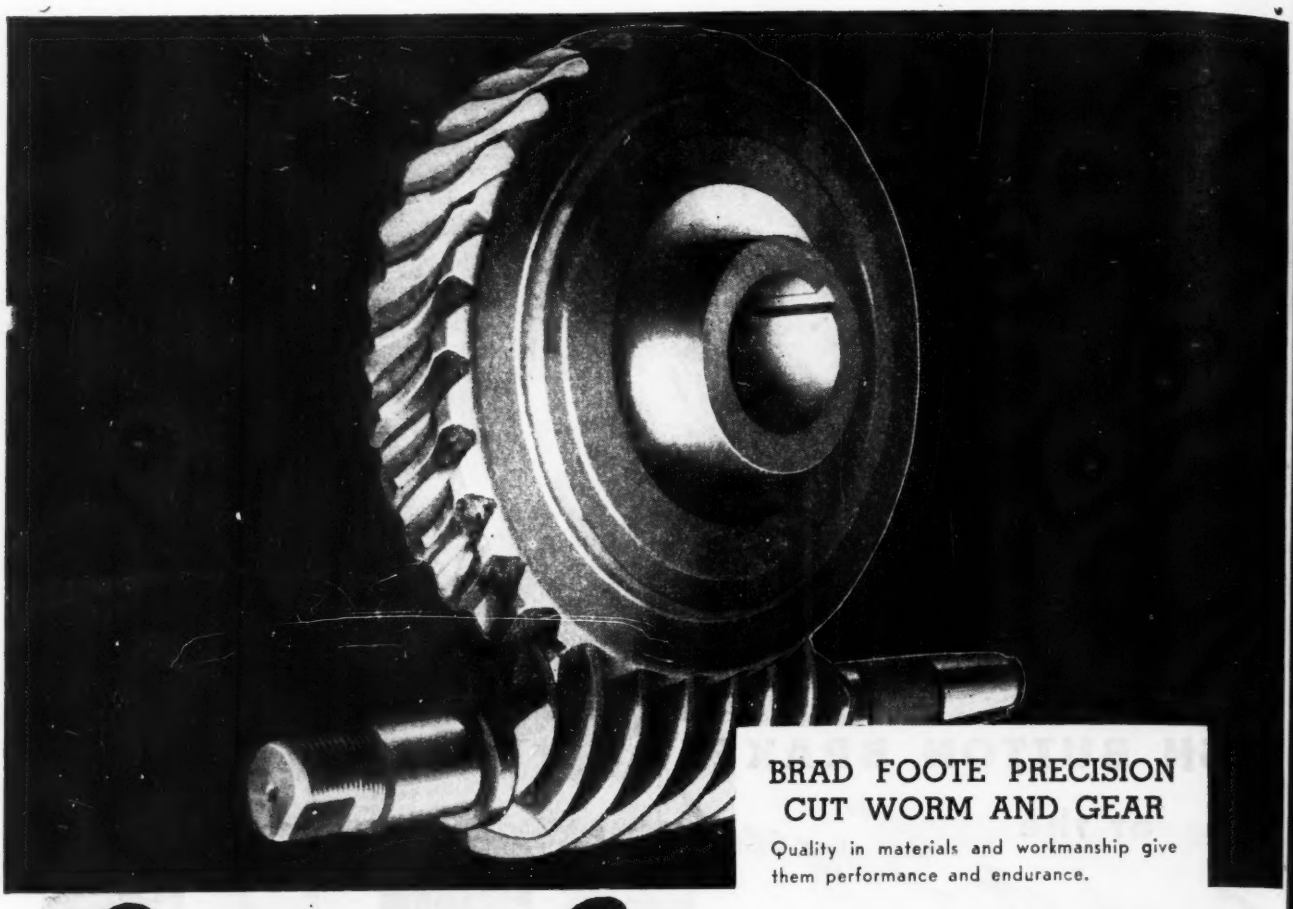
After the war, this type of electric motor engineering and design ability may prove invaluable to you. If you have specially tough motor problems, let EEMCO help you solve them

DATA: Dive flap actuating motor, 1¼ hp, 10,000 rpm—Equipped with magnetic clutch and brake—A double integral gear reduction unit operates screw jack actuator—Maximum load, 3,000 pounds, with 2½" travel on jack in less than 2 seconds—A control gear reduction drive turns cams for opening and closing specially developed limit travel switches—Frame 6230-C.

Send in your reservation today for "Custom Built Motors for a World of Needs," now in preparation. Copies of this limited edition will be distributed only on written request.

EEMCO

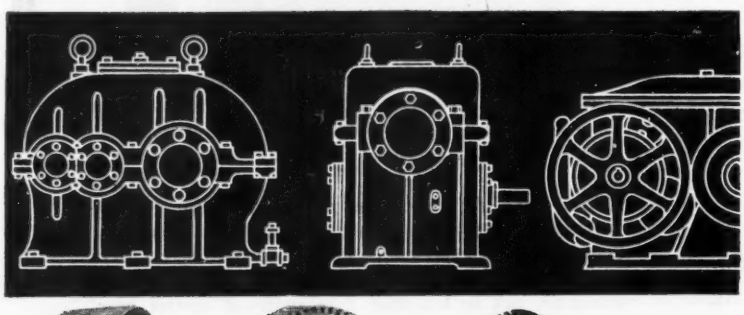
ELECTRICAL ENGINEERING and MFG. CORP.
4606 WEST JEFFERSON BLVD • LOS ANGELES 16, CALIF.



BRAD FOOTE PRECISION CUT WORM AND GEAR

Quality in materials and workmanship give them performance and endurance.

Brad Foote Gears

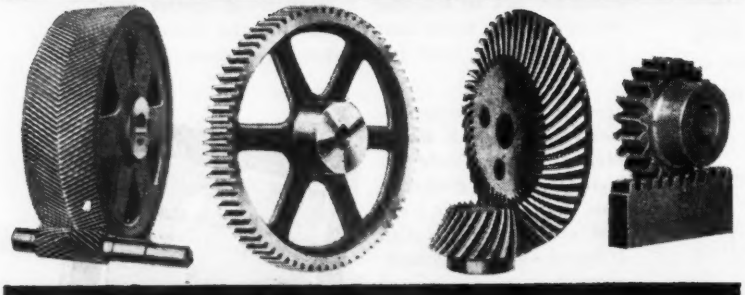


SPEED REDUCERS

There is a Brad Foote Speed Reducer to fit every need. Made in all sizes—all horse powers—any ratio—all tooth forms.

SPECIAL GEARS

Brad Foote special precision cut gears are fitted for installation on the most exacting jobs. Made in all sizes from any practical material in all tooth forms—Herringbone — Helical — Bevel — Worm and Gear—Spiral Bevel and Spur.



Over a generation of experience goes into every Brad Foote product and extensive plant capacity and shop equipment assure prompt delivery of great quantities of smooth running quality gears.

Write us about your geared reduction problem — full information will be promptly sent you.

BRAD FOOTE GEAR WORKS

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who want swift, compact and authoritative delivery of *all* the aeronautical news—with its background and meaning.

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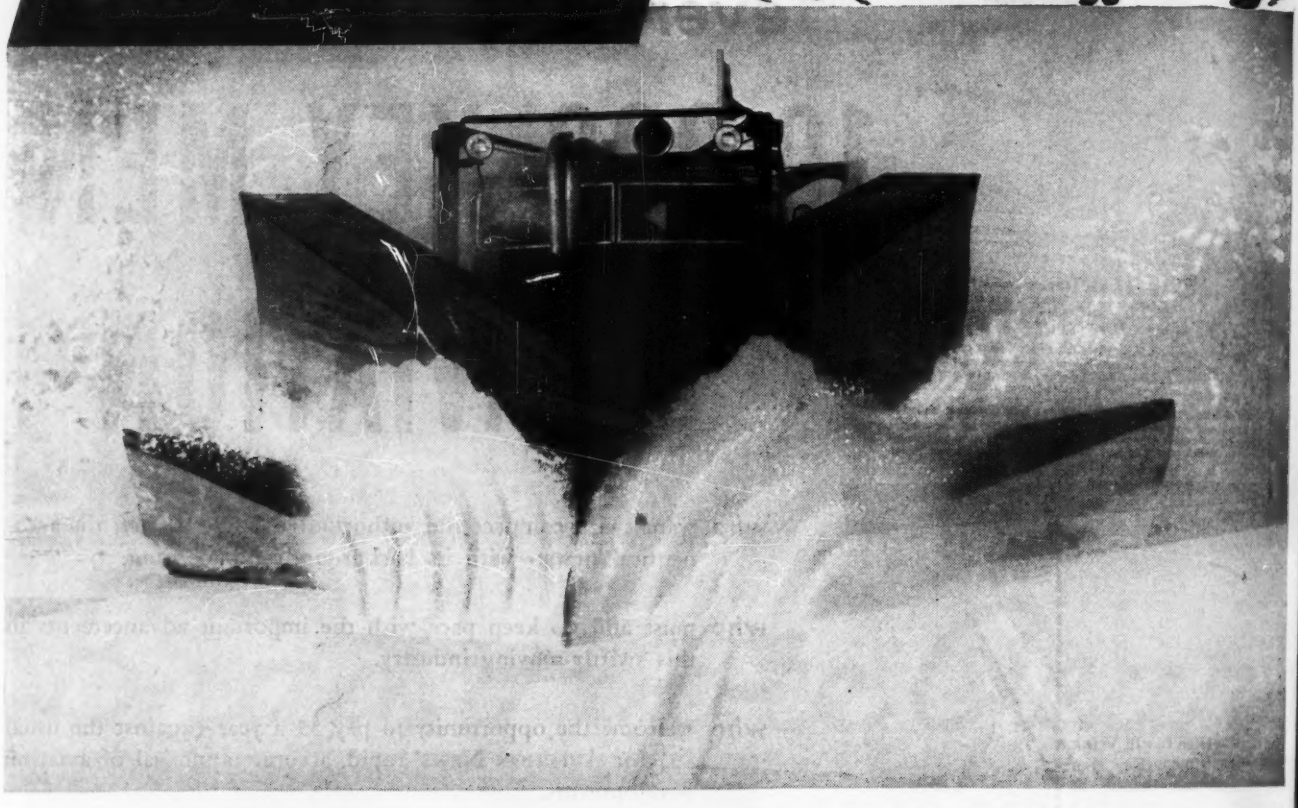
NO SPINS!
NO STALLS!



100% TRACTION MEANS FASTER CLEARING *with* WALTER 4-POINT POSITIVE DRIVE!

A truck without traction is helpless on snow, ice and slippery surfaces. Only Walter Snow Fighters have the positive traction which fully delivers tremendous motor power to FOUR driving wheels.

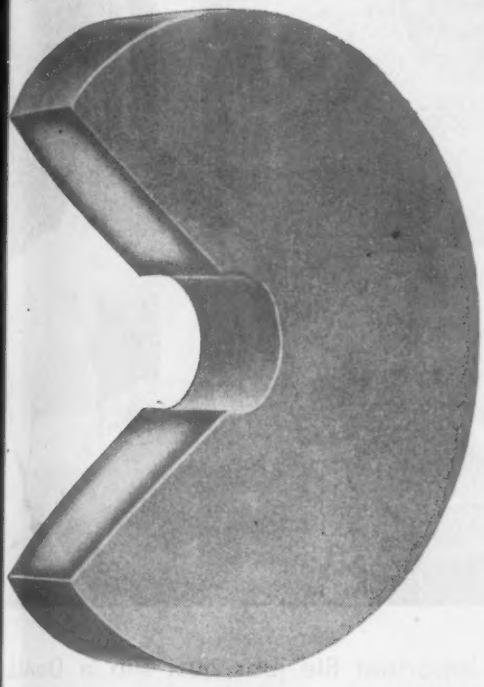
This traction is supplied by the exclusive Walter Four-Point Positive Drive. Three automatic locking differentials proportion power according to the traction of each wheel at any instant. Should one, two—even three—wheels momentarily lose traction, the mates carry on—eliminating the wheel-spinning, side-slipping and stalling that slow down or stop conventional trucks.

As a result, no other truck can match the performance of a Walter Snow Fighter. The 250 H.P. model shown above clears a 28 ft. width in one run—hits speeds up to 30 m.p.h.—throws snow far to the side to eliminate dangerous banks. Protect your airport with Walter Snow Fighters and you'll clear faster and fly sooner! Write today for complete information.

WALTER MOTOR TRUCK COMPANY
1001-19 IRVING AVE., RIDGEWOOD 27, QUEENS, LONG ISLAND, N. Y.

WALTER SNOW FIGHTERS

two-day curing job.. cut to 7½ minutes



Cross section of grinding wheel . . . formerly oven baked . . . heat soaks in slowly from surface.

Same section . . . now cured by radio-frequency heating . . . heat builds up speedily, evenly throughout.

The old, slow oven cure took 48 hours—just to heat the resin bond of a grinding wheel 8½" in diameter by 1¼" thick.

Now 7½ minutes are plenty . . . heat mounts at 20°C per minute . . . and splitting due to uneven heating is no longer a major hazard. Now it's done by radio frequency which heats dielectrics uniformly from center to skin.

This speedy heating is often applicable to processes in wood, chemicals, plastics, rubber, textiles and dozens of other products—with no waiting for heat to "soak in" and no rejects due to overheated surfaces.

This accurate, uniform heating is simplified into a "push button" job for unskilled help, with all equipment and controls in one safe, spacesaving cabinet. The cabinet is shielded to minimize interference with radio communications.

Single standard units are available in output capacities ranging up to 200 kw. The range of frequencies is wide enough for almost every dielectric and induction heating need. For more information, write for Descriptive Data 85-800. Or, for suggestions on a specific application, ask a Westinghouse engineer to call. Westinghouse Electric & Manufacturing Co., P.O. Box 868, Pittsburgh 30, Pa. J-08097

2 KW RADIO-FREQUENCY GENERATOR

This unit has a nominal output of 2 kw. Controls and meters are all conveniently located on front panel. Circuit breaker and relays are readily accessible through the lower door on left side of cubicle.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

Let DoALL do all your FILING

METALS · ALLOYS
PLYMETALS · LAMINATES
PLASTICS

Cast Steel Wrenches filed in 3½ minutes each. This is one of hundreds of jobs handled the DoALL way, which is 9 times faster than hand filing, 4 times faster than jig filing.

For occasional important file jobs, just slip a DoALL File Band on any DoALL Contour Machine and you're instantly ready to do the finest, fastest, smoothest filing —both internal and external work. Operates with a steady, one-way stroke that makes filing easy. Files wear evenly and last longer.

If, however, your Contour Machine is too busy cutting and shaping, the DoALL Band Filer is just what you need. Occupies 27"x34" floor space and files to close tolerances, anything up to 6" thick.

12 DIFFERENT FILE BANDS — Lengths to fit any DoALL Contour Machine or Band Filer.

Write for Circular
BAND FILING TO PRECISION TOLERANCES

DoALL

INDUSTRY'S NEW SET OF TOOLS

CONTINENTAL MACHINES, INC.
1305 S. Washington Ave. • Minneapolis 4, Minn.

Sales & Service Offices: Baltimore, Birmingham, Boston, Chicago, Cincinnati, Cleveland, Denver, Detroit, Erie, Grand Rapids, Hartford, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New York, Orlando, Philadelphia, Pittsburgh, Providence, Rochester, Rockford, St. Louis, San Francisco, Seattle, Syracuse, Toledo, Tulsa.

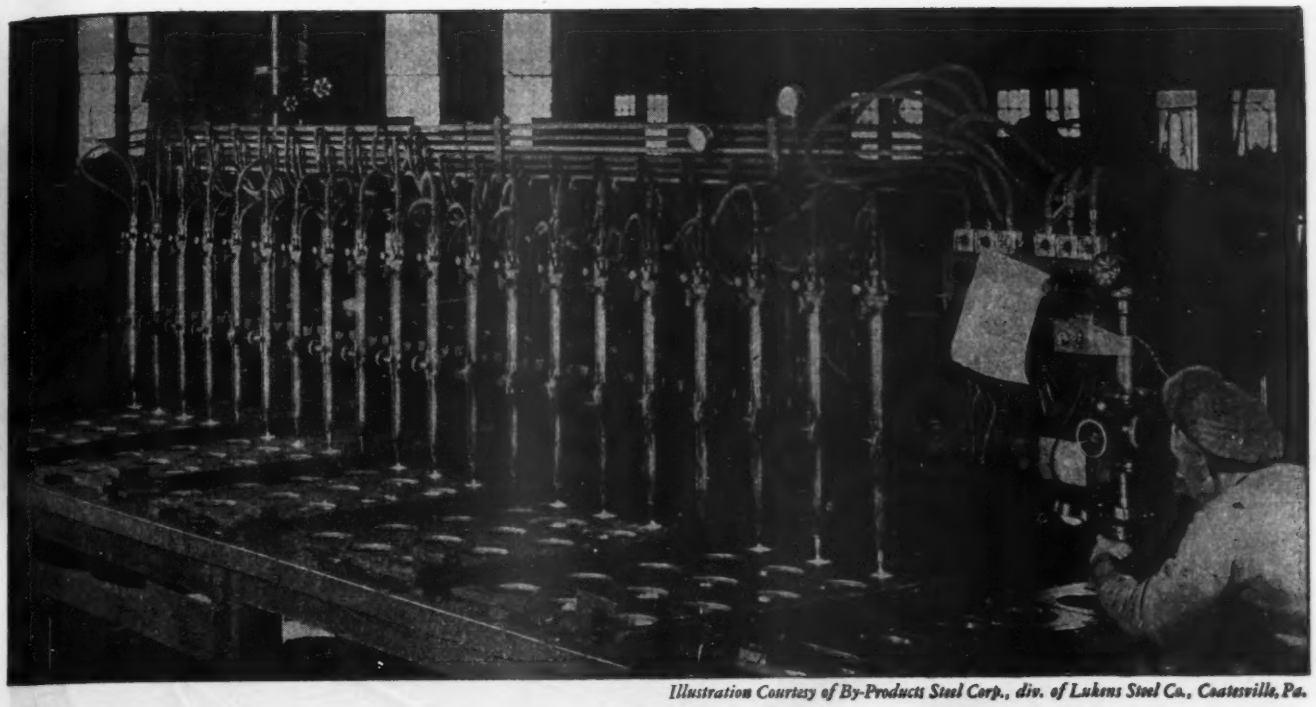


Illustration Courtesy of By-Products Steel Corp., div. of Lukens Steel Co., Coatesville, Pa.

CUTTING METAL PARTS, CUTTING COSTS

with the

AIRCO No. 6A OXYGRAPH

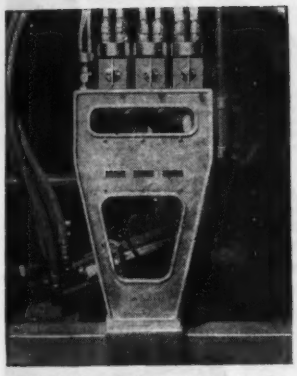
The motor-driven Airco No. 6A Oxygraph is designed to provide the speed, flexibility and accuracy essential to lowest-cost production of flame-cut steel shapes in any quantity.

It quickly cuts steel plate of light and heavy sections to any shape and size. It can be used for beveling, squaring, straight cutting, stack cutting—changing from one job to another in minimum time—using up to eight torches with standard equipment.

The listing below of some of the plus factors of the No. 6A Oxygraph provides an inkling of its wide acceptance throughout the metal working industry as an important production tool:

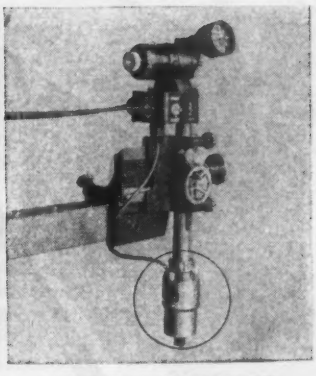
1. Extreme accuracy under load—the pantograph design provides maximum resistance to torsion and deflection.
2. The rigid, sturdy base gives trouble-free support to the stout vertical posts and pantograph assembly.
3. Manual, magnetic or spindle type tracing devices can be used.
4. Ball-bearing mounted arms provide uniform, friction-free response to tracing device movement.
5. Centralized gas control unit for individual flame control saves operator's time.
6. Hose or cable lines can't snarl or pinch.

For further details write Department A, New York Office for Catalog ADC-628—or ask your local Air Reduction office.



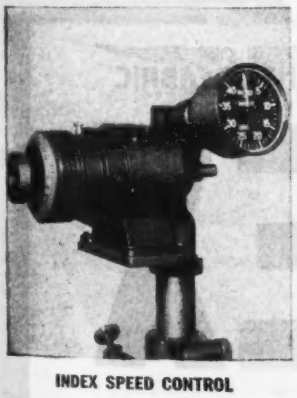
CENTRALIZED GAS CONTROL UNIT

Gives the operator remote control of the pilot light, acetylene, preheating and cutting oxygen from his station at the tracing device.



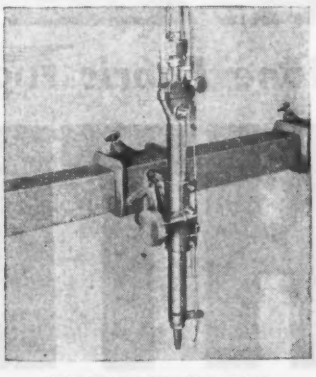
MAGNETIC TRACING DEVICE

An exclusive Airco feature, this device guides cutting torches by automatically following the contour of a steel cam or template.



INDEX SPEED CONTROL

Permits easy, accurate adjustment of torch travel speed during cutting. Speed is visible on the Tachometer attached to the unit.



ADJUSTABLE TORCH HOLDER

Allows torch to be moved easily and locked tightly at any desired position along the bar or tilted up to 45° for bevel cutting.

AIR REDUCTION

General Offices: 60 East 42nd Street, New York 17, N. Y.

In Texas: Magnolia Airco Gas Products Co. • General Offices - Houston 1, Texas

Offices in All Principal Cities

AIRCO

Gas Cutting Machines

A Type and Size for Every Cutting Need

IDEAL TOOLS FOR SPEED, FLEXIBILITY AND ACCURACY IN METAL SHAPING

THIS IS NO TIME TO SIDE-TRACK QUALITY

• Production for our men in the air calls for full speed ahead. Everything else must be "side tracked".—That is, everything but Quality. Today, FLIGHTEX Quality is even *better* than ever. Tomorrow, thanks to FLIGHTEX research leadership, FLIGHTEX Quality will be better than today!

World's Premier Airplane Fabric FLIGHTEX FABRIC

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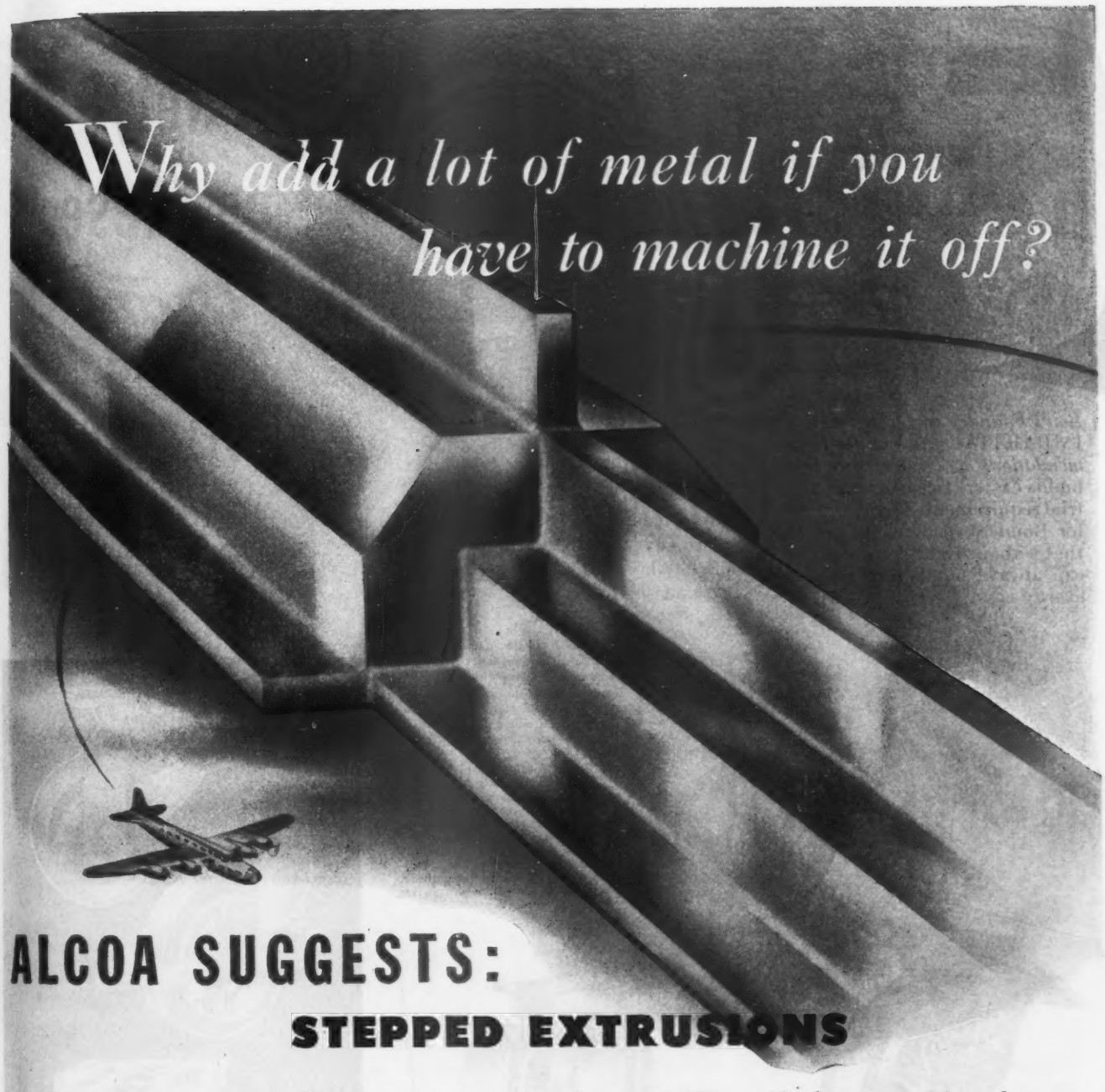


ALCOA SUGGESTS:

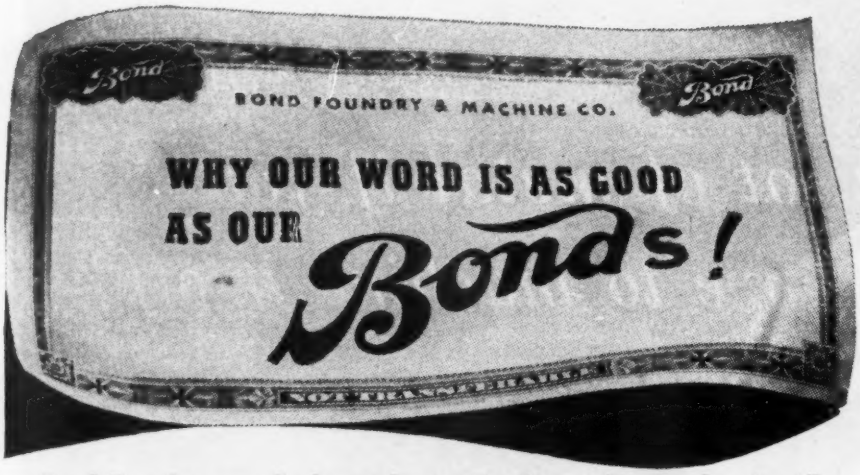
STEPPED EXTRUSIONS

Airplane wing spar caps call for tapers consistent with strength requirements. Reducing straight sections to a taper requires expensive, time-consuming machining. Alcoa's stepped extrusions can be used to reduce the amount of metal to be removed to produce a taper. Production is speeded up, costs reduced.

Stepped extrusions can provide a larger, integral section from which the attachment fitting is cut out. This avoids the extra weight and cost of a splice.

Will stepped extrusions fit your production? Each case must be analyzed individually from a design and an economic standpoint. Alcoa engineers will gladly give you the benefit of their experience to determine the facts. ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA THINK OF **ALUMINUM**



Bond Foundry can afford to make IMPARTIAL *truck caster recommendations* . . . because Bond builds casters to suit every industrial requirement. There's no need for Bond to recommend a caster that's about right . . . when Bond can always supply a caster that's *exactly* right.

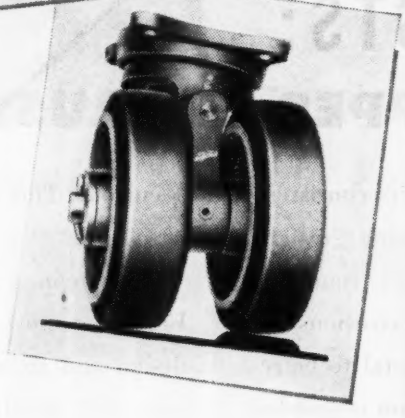
Bond specialization does it. *All* casters produced at Bond are for *industrial* use. Only through such concentration can a manufacturer provide casters in sufficient variety to cover all industrial needs. Write today for free catalog K-34 . . . and see for yourself.

Rely on These Bond Reliables

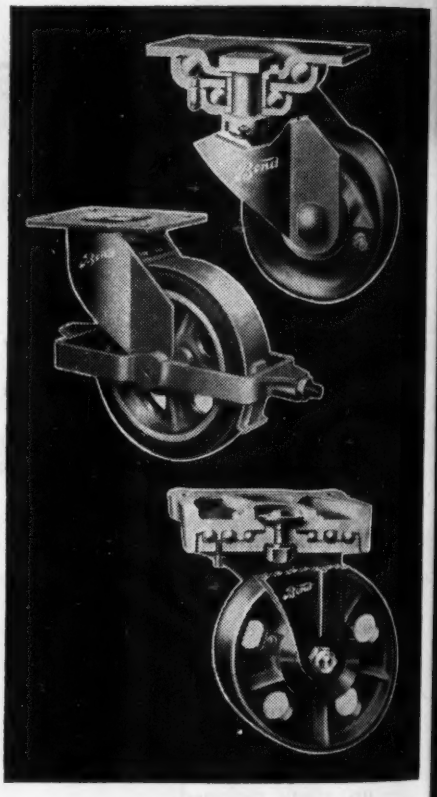
TO HELP SPEED UP YOUR PRODUCTION PROGRAM

Bond 36-A Caster. *(Left)* Basically different in design, this caster combines easy swiveling with long service because of the special arrangement of its double ball races and its use of durable Bond caster metal. Pressure lubricated throughout.

Bond Dual Wheel Caster with Oscillating Axle. *(Below)* Oscillating axle distributes load evenly on both wheels, permitting them to hug the floor no matter how rough the surface. Double ball race construction. Pressure lubricated throughout. Also supplied with Swivel Lock.



Bond V-Grooved Wheel Caster. *(Above)* Built especially for use on track line assembly. Saves time and floor space, reduces effects of floor vibration. Double ball race construction. Pressure lubricated throughout.



Bond 140-A Caster *(top)*. The preferred light-weight caster. Sizes from 4" to 12" with capacities from 450 lbs. to 4000 lbs. per caster. Sturdy, all steel construction reduces caster breakage—cracking—or excessive wear even under peak loads. Swivels with frictionless ease. Pressure lubricated throughout.

Bond 1640-A-8 Wheel Brake Caster *(center)*. Same construction as 140-A but equipped with wheel brake. Available only on 8" wheel size.

Bond 118-A Caster *(below)*. Triple ball race caster for heavy duty and unusually hard service. Two large diameter, machine finished races carry the load; inner race absorbs all side shock. Cupped raceways assure even wear and long life. Pressure lubricated throughout.

BOND FOUNDRY & MACHINE COMPANY, MANHEIM, PA.

Bond
Reg. U. S. Pat. Off.

TRUCK CASTERS
Built-for-the-Job

This is the nineteenth of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME.

"The Sky Really Is the Limit!"

says T. E. BRANIFF, President, Braniff Airways

NOT MANY YEARS AGO, *man was painfully limited by the natural barriers of his world, by mountains, rivers, and the sea. Now the great American planes which fly tons of supplies across these barriers have reduced them to symbols on a map; but the* national *barriers remain.*

"Let us overcome these national *barriers as we have overcome the natural barriers and, 'The sky really* is *the limit,' to aviation's ability to expand our postwar trade.*

"Let our planes be free to carry American salesmen and American goods across any country in the world—let every airport be a free port—and aviation can use its unshackled power to create more jobs, more wealth, in a peacetime world.

"Then, with plane service linking every U. S. city and town with all the commercially important cities in the world, aviation shall at last come into its own."

• • •

Aviation's plans for the future range all the way from super airliners to packaged airports. But none of these plans will be translated into flight-hours or airfields or trade routes—until it is properly *sold!* And perhaps the first place for aviation to talk up its ideas is the "test pilot" market of U. S. citizens who are always ready to buy progress whenever they see it in business or in private living.

***This is the market aviation thinks of when it thinks of the more than a million TIME-reading families** (America's best prospects for planes and air travel)—and the hundreds of thousands of TIME-reading executives (whose positions in American business make them the natural national vanguard for any programs aviation may set up). The best place to talk to these people is in TIME—for they vote* TIME their favorite magazine 7 to 1 over the runner-up.

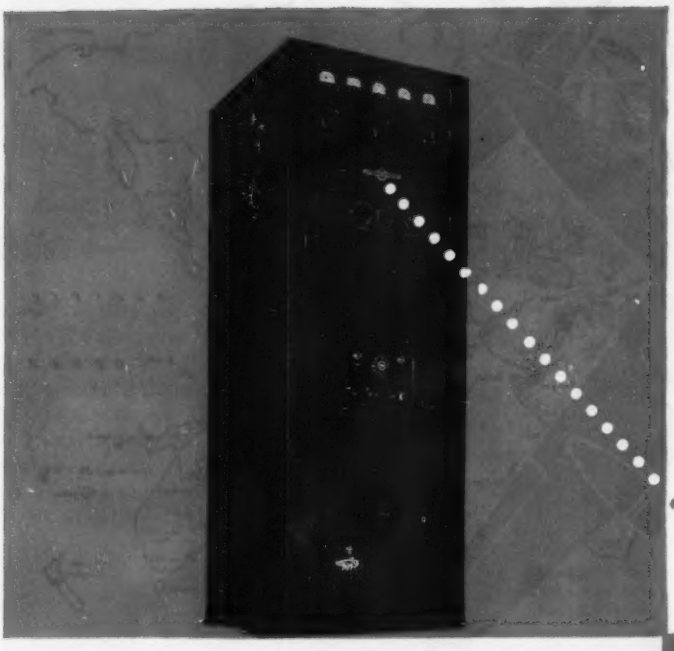
Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here gives them wider circulation in the name of

AVIATION'S SILENT PARTNERS

TIME

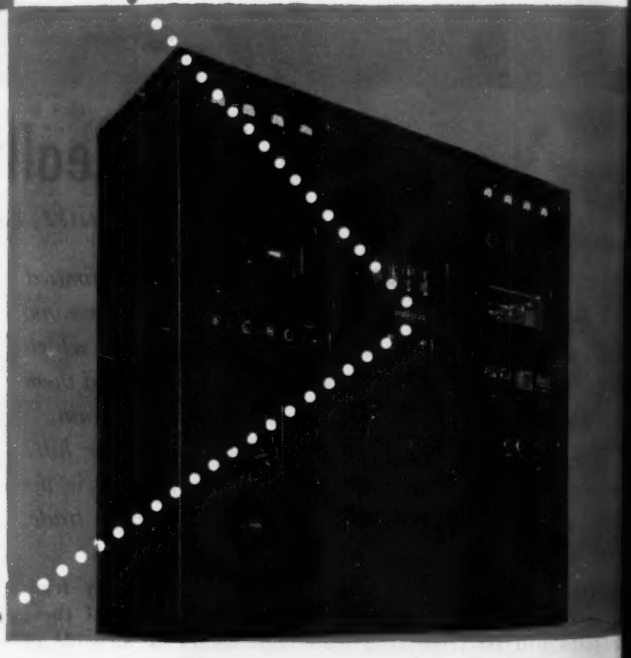
THE READERS OF TIME

Announcing Two Highly Developed Collins Autotune* Transmitters



Collins 16F-9—Nominal power output: 300 watts phone; 500 watts CW. Frequency range: 2 to 18 mc. Ten quick-shift frequencies.

Collins 231D-13—Nominal power output: 3000 watts phone; 5000 watts CW. Frequency range: 2 to 18 mc. Ten quick-shift frequencies.



IN DESIGN and construction, these transmitters reflect intense engineering endeavor and hard won experience in meeting the requirements of war. The most advanced laboratory refinements are combined with military ruggedness on a production-line basis!

The lessons learned since Pearl Harbor have increased the already high reset accuracy and dependability of the Collins Autotune. Any one of ten frequencies is reliably, precisely available at the flip of a dial, from a remote point. The standard models are crystal controlled, and special models are available with tunable master oscillator control.

The physical size of these transmitters has been increased, and components specially Collins re-designed, to increase safety factors throughout.

The renowned Collins pi network matches into a wide variety of single wire or vertical antennas. The 231D-13 also matches into a 600 ohm balanced transmission line from 4 to 18 mc.

Frequency-shift keying is available, making it possible to use these transmitters in printing telegraph circuits.

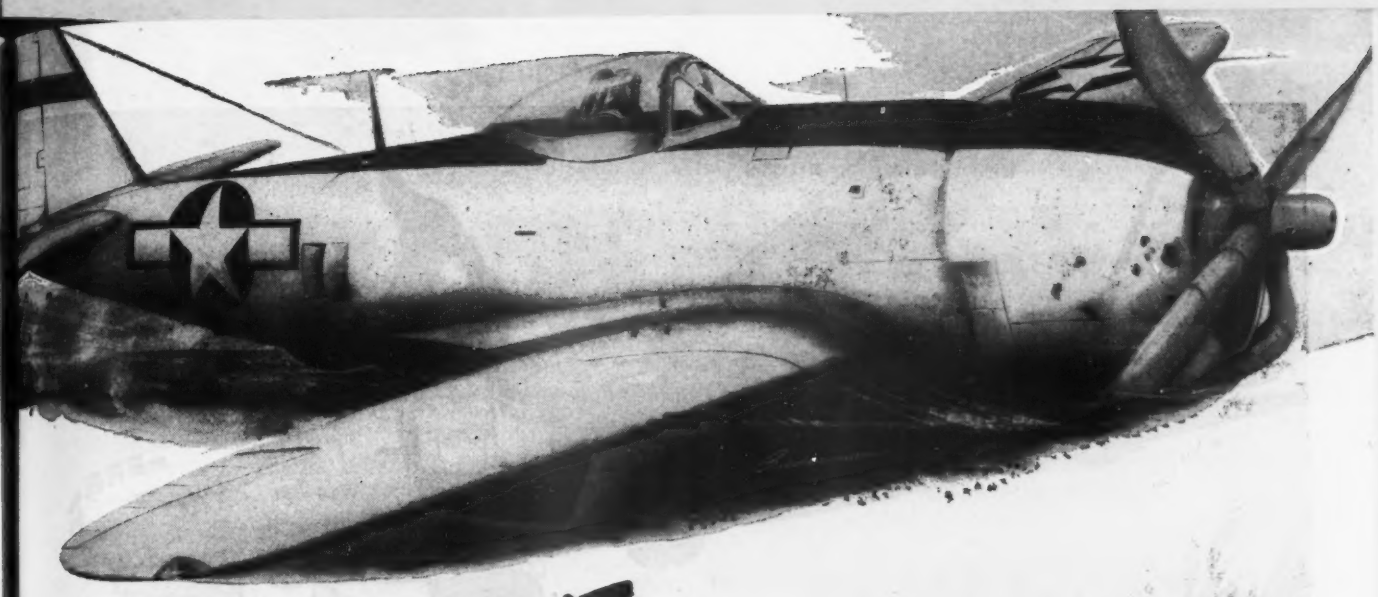
We will welcome inquiries and an opportunity to make recommendations for your particular application. Collins Radio Company, Cedar Rapids, Iowa.

*The Collins Autotune is a repositioning mechanism which quick-shifts all tuning controls simultaneously and with extreme precision to any one of a number of pre-selected frequencies. Patents issued and pending in the U. S. A. and other countries.

IN RADIO COMMUNICATIONS, IT'S . . .

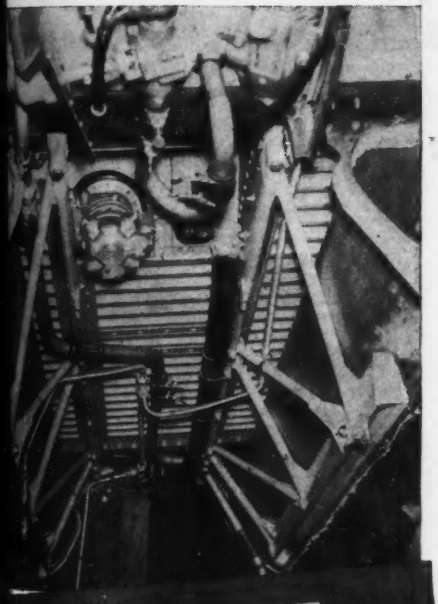
ARMY E NAVY

COLLINS



THUNDERBOLT Takes a "belly-whopper" SAFELY!

Shelby Seamless Steel Tubes are used to brace the crash skids of the P-47 Thunderbolt. On the strength of these braces largely depends the safety of both pilot and plane when a forced landing without landing gear must be made.



FOR paralyzing attacks at tree top level or for police duty in the stratosphere, the Thunderbolt serves equally well. Pilots love it because it packs a powerful punch. It flies high, fast, and far and is more heavily armed and armored than any other single-engined fighter.

In fighter-bombers, trainers and scout planes, SHELBY Steel Tubing provides maximum strength in vital parts with minimum weight. Engine mounts and landing gear successfully absorb tremendous vibrations from powerful motors and rough landing fields. Spar chords, wing struts and braces resist the strain of sudden maneuvering and dives—faster than 700 miles per hour.

In countless applications SHELBY Seamless Steel Tubes have proved they can do the tough jobs which aviation expects. In Thunderbolts, Commandos, Flying Fortresses, Liberators and dozens of other planes where the elimination of dead weight is an important consideration, seamless steel tubes have been chosen because they have a higher strength-weight ratio than any other type of construction. No matter what type of aircraft tubing you need, NATIONAL's Complete Aircraft Tube Service can furnish it.

SHELBY SEAMLESS *Aircraft Tubing*

WALLS WITHOUT WELDS

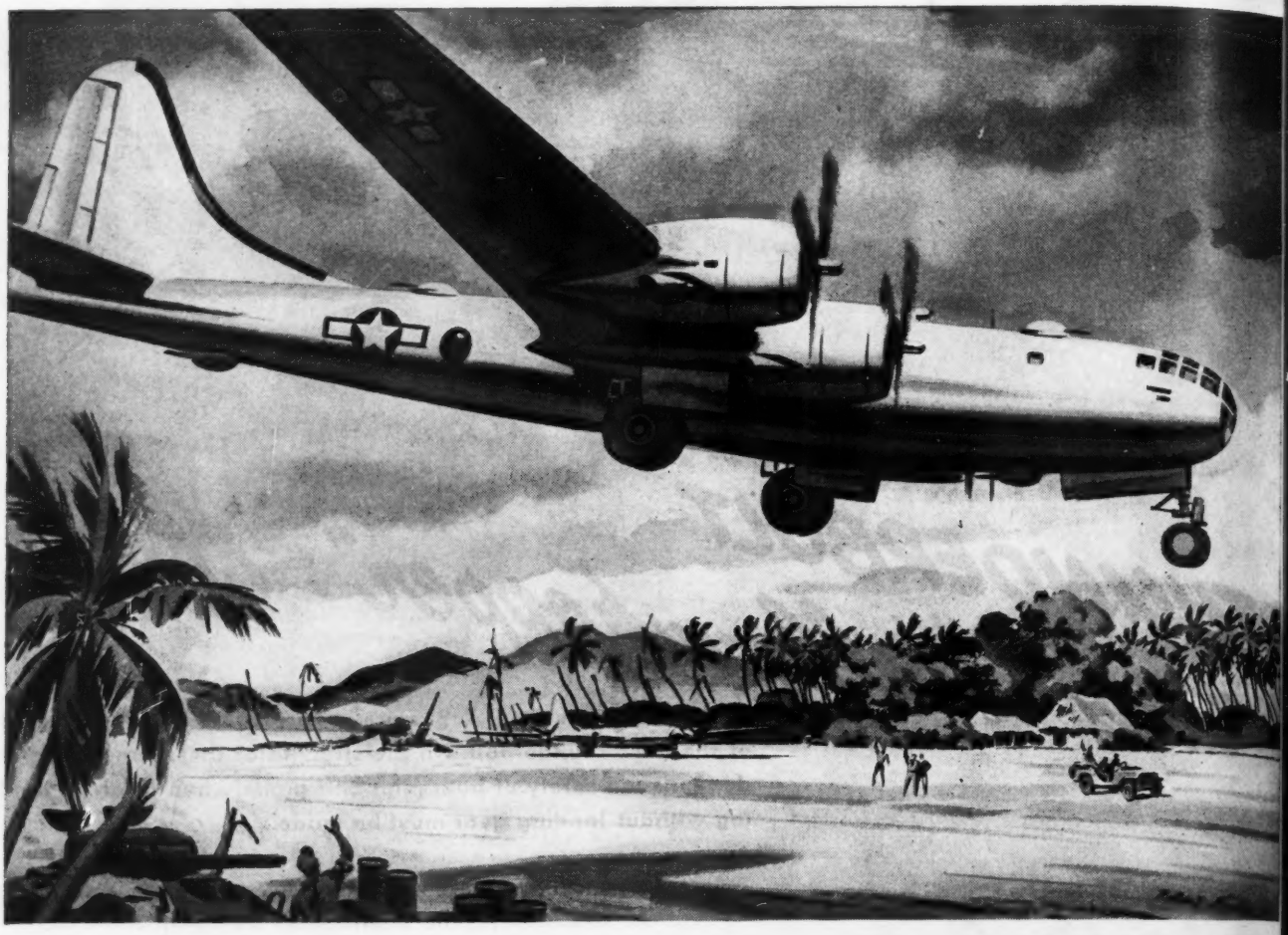
NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

USS

UNITED STATES STEEL



A little Nickel makes landing SAFER for B-29's

No ordinary metal can curb the tremendous landing momentum of the world's mightiest warplane... the B-29.

It takes metal that does more than resist the shock, abrasive wear and galling of brake drums.

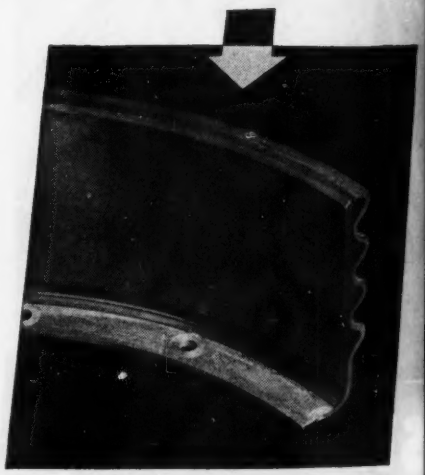
Essentially the metal must dissipate intense frictional heat from restricted surfaces. It must resist distortion and heat-checking under all kinds of adversities.

That's why experienced engineers specified an alloy containing nickel... nickel-chromium-molybdenum (high carbon) iron... for B-29 brake drums.

Centrifugally cast against a steel shell, this nickel alloy iron provides a machinable structure in the light-sections involved. The composite design gives the important combination of strength and heat-and-wear resistance.

These drums are aptly given the trade name "Centrifuse" by Centrifugal Fusing Company, a supplier of those used on large bombers. "Centrifuse" drums are also used on other types of aircraft... and on combat cars and armored vehicles.

These outstanding brake drums illustrate once more the product improvement which can be made with Nickel. An alloy containing Nickel may improve your product. We invite consultation on the use of Nickel or Nickel alloys in your equipment.



Close-up view of a section cut from a typical Centrifuse brake drum, showing fusion between steel and alloy iron. Besides resistance to wear and to heat-checking, other advantages include minimum scrap loss and maximum soundness in the product. Range of sizes run from 8" to 20" diameter. Centrifugal Fusing Company alone has produced over 4,000,000 pounds of such castings.

THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street, New York 5, N. Y.

A FOXHOLE TENANT HAS SOMETHING TO SAY!

"Ever spend a weekend in a foxhole . . . No? Well . . . until you have, it's pretty hard to understand what those lads in "that wild blue yonder" really mean to us guys slogging along in the mud . . . Here's a quickie . . . so you'll see what I mean. Back around what the folks at home call Holiday Season, our outfit is makin' time towards Mr. Siegfried's line, when the weather decides to turn zero-zero . . . Then, a foxy gent named von Rundstedt threw the works at us, all schedules for Berlin went haywire, and speaking for our cocky spearhead in particular, we dug right in fast . . . and just tried to stay alive . . .

"For three long days . . . and longer nights . . . we were cold, hungry, miserable, and let nobody kid you . . . scared . . . plenty scared . . . for old man despair sure clamps down when you're forced to sweat it out that way . . .

"... Late the third day . . . it seemed a year . . . the pea soup drifted away, the sun poked thru the

clouds . . . and then . . . man oh man . . . those Thunderbolts came down. . . Prowling tanks and cunningly hidden machine guns just went right out of business . . . road blocks that had held us helpless went the way of the other horrors . . . Heinie's fire began to slack off, and those of us who could, crawled out, got organized, and went into high once again. Me, I'm an infantryman, and that's the top outfit in my book . . . but I gotta hand one thing to those *buzzards . . . when it comes to paving the way over a tough spot, they're the all time, all American steam rollers."

*** REPORTS FROM ALL BATTLE-FRONTS STRESS THE VITAL CONTRIBUTIONS OF THE THUNDERBOLT TO EVERY PHASE OF COMBAT....**

REPUBLIC AVIATION
CORPORATION

Makers of the Mighty Thunderbolt » » » *Farmingdale, L. I., N. Y. • • Evansville, Ind.*

Loading anti-tank gun into WACO CG-4A. USAAF photo

Evans loading engineers plan now for future carriers of the sky

Gliders are on the wing! The Army has demonstrated their effectiveness in mass movements of men and supplies. Production is at a new high, and recently announced tests of super gliders indicate that serious engineering thought is being given to the glider as a future carrier of passengers and freight.

Evans will be ready with the proper tie-down equipment, Sky Seats and other Sky Products for whatever size or shape gliders and powered planes may take. For Evans engineers have specialized in loading equipment since 1915—have pioneered and perfected products that have helped improve air transportation for the men and cargoes of war. They are looking ahead confidently to many new developments in these carriers of the sky.

Many airplane manufacturers and airline operators are using the services of Evans engineers to help solve their loading problems. You, too, can have this help.

* * *

Vision to Anticipate the Needs of Tomorrow
Creates New Industries Today

C. L. Evans
PRESIDENT

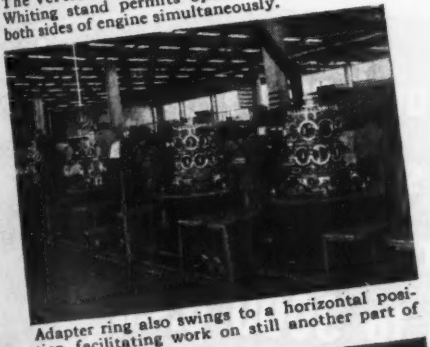
SKY PRODUCTS DIVISION

EVANS PRODUCTS COMPANY
DETROIT 27, MICHIGAN

Evans War Products: Machine Gun Mounts • Tank and Automotive Heating and Ventilating Equipment • Evanair Water Heaters • Aircraft Engine Mounts • Airplane Landing Gear Beams • Battery Separators • Prefabricated Houses • Plywood • Skyloader • Utility Loader • Auto-Loader • Auto-Railer • Auto-Step • Stampings • Evanair Domestic Heating Equipment

Photos courtesy of the Nash-Kelvinator Corporation

The vertically tipped adapter ring of this Whiting stand permits operators to work on both sides of engine simultaneously.



Adapter ring also swings to a horizontal position, facilitating work on still another part of the engine.

Stand and completed engine are easily wheeled away for testing operations.

They build big ones *Fast* AT NASH

Typical result of Whiting's sixty years of experience in helping solve industry's problems is this long line of Whiting engine stands which speed production at a Nash Motors plant. The stands were designed by Whiting and Nash engineers, working in close collaboration.

Matched to the exact requirements of each job and to successive steps in the various operations, Whiting maintenance, handling, and loading equipment speeds work and eases manpower shortages. The Whiting Collateral Engineering Service co-operates with operator and manufacturer in the development of specialized equipment. Whiting engineers will gladly discuss your equipment problems with you.

WHITING CORPORATION

AVIATION DIVISION

Main Office and Plant: 15614 Lathrop Ave., Harvey, Ill.
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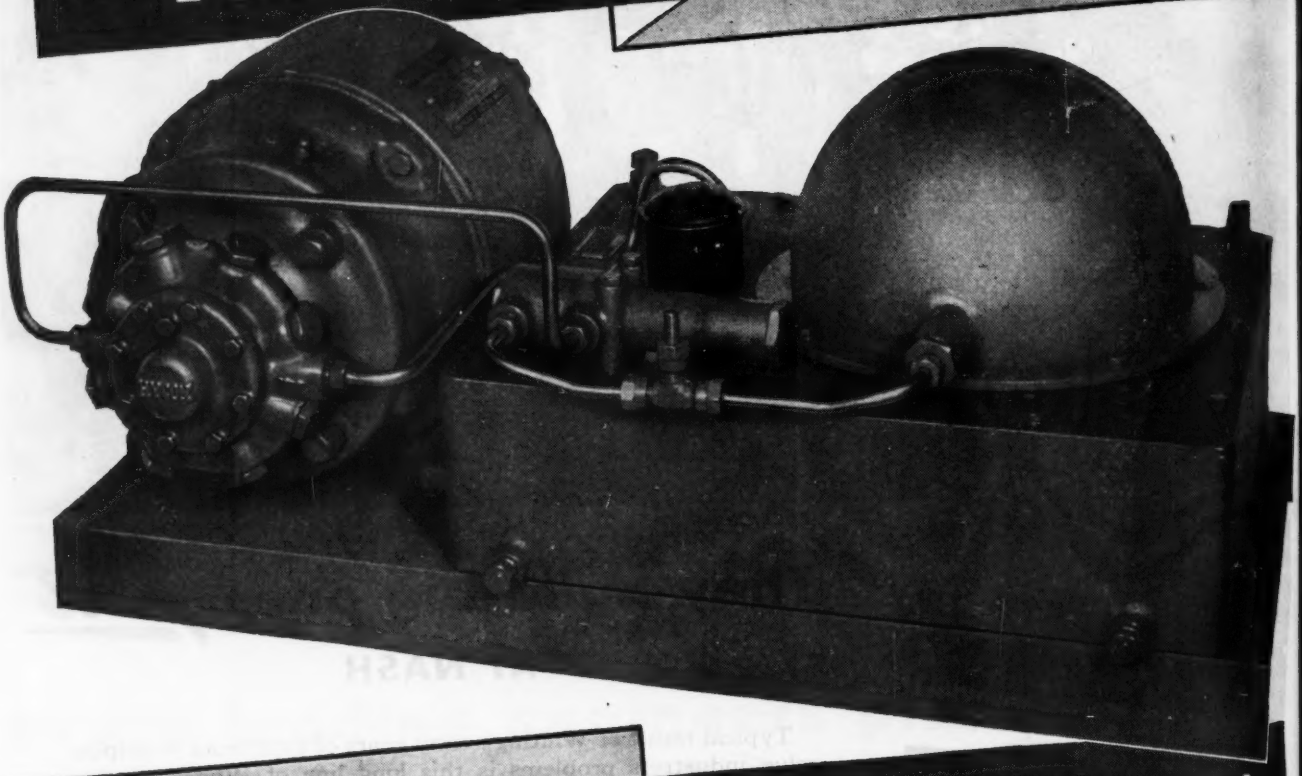
Branch Offices in New York, Philadelphia, Pittsburgh, Detroit, Cincinnati, and St. Louis.

MATCHED HANDLING AND MAINTENANCE EQUIPMENT

HYCON

3000 p.s.i. Hydraulic Power Unit

3 HP Motor
8 cylinder Pump
Unloading Valve
Accumulator and Reservoir



A small compact unit for machine tools, hydraulic presses and test equipment

Quickly and easily installed for smooth reliable hydraulic operations up to 3000 p.s.i.

Specifications and Engineering Data on Request

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

420 Lexington Avenue, New York 17, N. Y. Factories: Watertown, N. Y.

NEW WELDING CONTROL

GOOD FOR ALL 3

SPOT
PULSATION
SEAM

Flip this switch to change the control from spot or pulsation to seam welding.

New CR7503-C110 welding control. Inset shows the master control station, which can be removed for mounting on the welding machine.

Accurate timing • Smooth heat adjustment • Fully electronic

As this control is of the synchronous-precision type, it provides the accurate repetitive timing, even with instantaneous or sustained line-voltage variations, so essential to highest-quality welding. This control, the most versatile of all G-E resistance-welding controls, is not only ideal for the types of work given below, but it can also be used where it is desirable to do all three types of work on one machine.

Spot or Pulsation Welding

This control is particularly well suited for these two types of welding because of its wide timing range. It can be used in the welding of thin-gage metals where consistent timing of as low as one or two cycles may be required, in the welding of heavy-gage metals or in projection welding where pulsation welding may be required, or in special welding applications where pulsation welding may be required with a minimum heat and cool time of one or two cycles.

The timing range in spot welding is from 1 to 30 cycles.*

In pulsation welding, heat and cool time, are independently adjustable from 1 to 30 cycles*, and the impulse-counting circuit is adjustable from 1 to 15 impulses—independent of heat or cool time settings.
*When used on a 60-cycle power supply.

Seam Welding

Good seam welding is possible with this control because the accurate timing circuit and the independent adjustment of heat and cool time (in complete-cycle steps) eliminate timing variations and transient currents. Heat and cool time are independently adjustable from 1 to 30 cycles*.

Heat Control on All 3

Smooth heat adjustment is provided by the phase-shift method of heat control. This eliminates the need for many heat points on the welding transformer. In addition, a voltage- or current-regulating compensator can be added by simple interconnections. Also, this welding control when equipped with a tempering attachment makes possible good results in the spot welding of thin-gage air-hardenable steels.

*When used on a 60-cycle power supply

Send This Coupon for Your Copy of Our New Bulletin

General Electric Company, Section D645-33
Schenectady 5, N. Y.

Please send me a copy of your new bulletin (GEA-4220). I'd like more information about this new welding control.

Name.....

Company.....

Address.....

.....

Buy all the BONDS you can—and keep all you buy

GENERAL ELECTRIC

MACHINE TOOLS BRING SPEED and ACCURACY to PRODUCTION

Take *aircraft engines*, for instance. In the turning out of these aircraft engines, Ex-Cell-O is a definite factor. Not only has Ex-Cell-O one of the country's largest precision aircraft parts divisions, but Ex-Cell-O precision machine tools are being used extensively throughout the aircraft industry to produce the many thousands of precision parts needed for aircraft engines. These parts must have a high degree of precision and finish . . . rigid specifications must invariably be observed . . . the parts must be produced as fast as possible. This is the reason why Ex-Cell-O precision standard and special machine tools have long been preferred by managements and workers for production of these vital parts.

Illustration above shows fixture developed by Ex-Cell-O for use in facing both sides of aircraft flange and in turning hub diameter on each side, the fixture being operated by a hydraulic cylinder connected to the machine circuit. It carries four tungsten carbide tools that are synchronized mechanically and have individual micro-adjustment in two directions. All four tools reach the end of their cut simultaneously. *Machine used:* Ex-Cell-O 112-C Precision Boring.

EX-CELL-O CORPORATION

DETROIT 6, MICHIGAN

XLO

EX-CELL-O *for* PRECISION

SPECIAL MULTIPLE WAY-TYPE PRECISION BORING MACHINES • SPECIAL MULTIPLE PRECISION DRILLING MACHINES • PRECISION THREAD GRINDING, BORING AND LAPPING MACHINES • BROACHES AND BROACH SHARPENING MACHINES • HYDRAULIC POWER UNITS • GRINDING SPINDLES • DRILL JIG BUSHINGS CONTINENTAL CUTTING TOOLS • TOOL GRINDERS • FUEL INJECTION EQUIPMENT • R.R. PINS AND BUSHINGS • PURE-PAK PAPER MILK BOTTLE MACHINES • AIRCRAFT AND MISCELLANEOUS PRECISION PARTS

Of shoes—and ships—and sealing wax—"

What Alice found "through the looking glass" was no more wondrous than the new world of petroleum as seen by Cities Service scientists...In this true Wonderland of Research the black gold of oil serves an ever-growing list of needs...Yes, it polishes SHOES ...and powers SHIPS...and SEALS preserves...and does a lot of other things that hold bright promise for tomorrow.

IN this war, Cities Service is represented on the battlefronts with everything from gasolene and lubricants to highly developed specialties, such as Cities Service Anti-Corrode, Insecticides, Detergents, Plastics and Explosives.

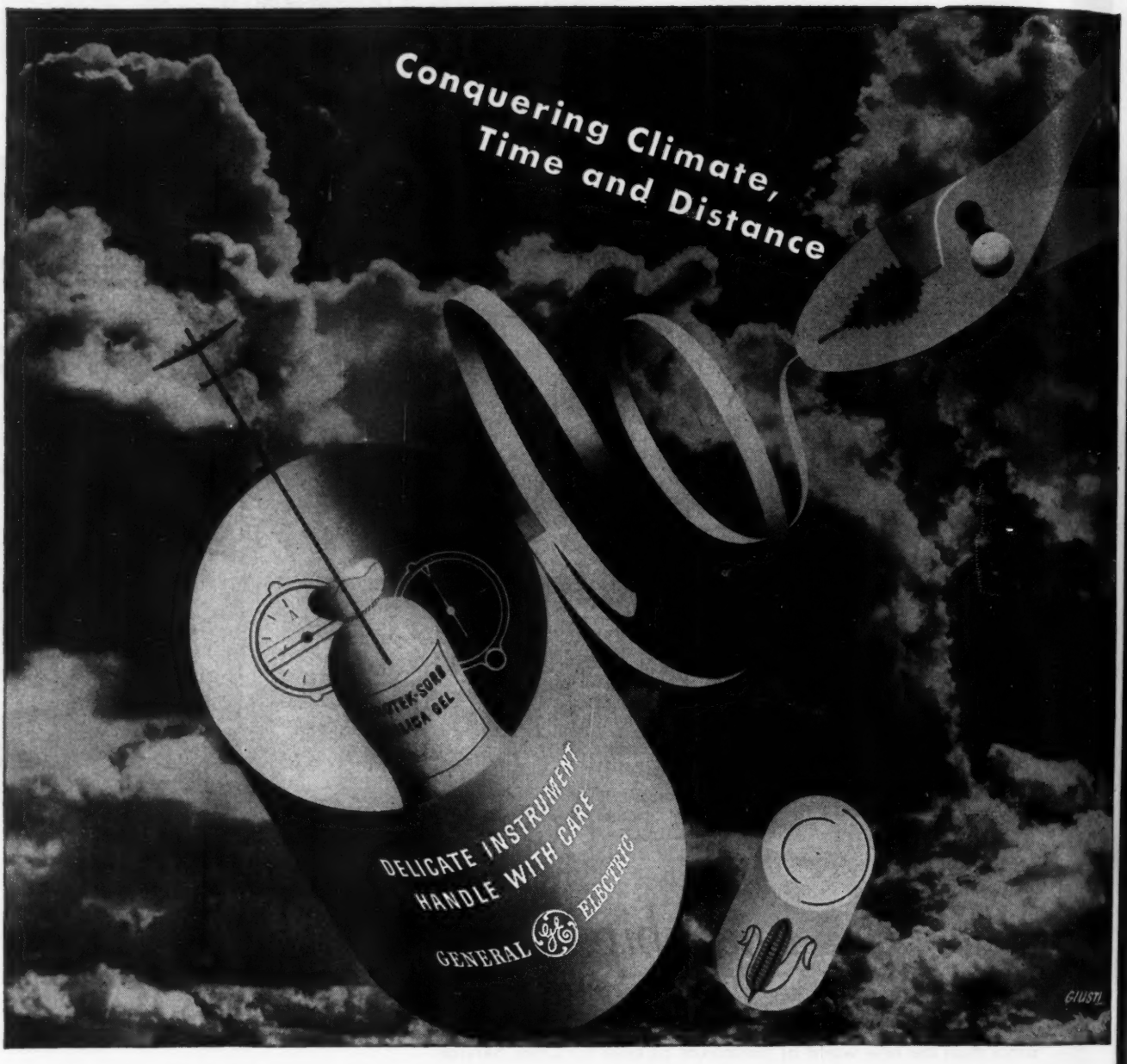
And to this list we have recently added tremendous quantities of 100-octane aviation fuel—enough to send great fleets of heavy bombers over Germany every day—as well as enough butadiene capacity to supply one-eighth of the nation's normal rubber demands. Such are the amazing production figures of the new Cities Service Refinery at Lake Charles, Louisiana—one of the world's largest and most modern refineries devoted to Victory!

When peace comes, you can look to Cities Service for important new developments. For the beginnings of this company go back almost as far as the Petroleum Industry itself!

In the future as in the past, Cities Service will continue to pioneer.

Progress through Service—

CITIES SERVICE



ONE of the vital tasks of today's mechanized conflict is the protection of the instruments of war, in transit and storage, against the ravages of moisture damage — rust, corrosion, mildew and mold.

Dehydrated packaging, using Protek-Sorb* silica gel, successfully supplies this protection . . . this method is the result of years of Davison research in the field of silica gel.

Sealed in a moisture-vapor-proof barrier, either flexible, metal or glass, with Protek-Sorb, the perfect dehydrating agent, implements arrived clean, factory fresh, ready for instant use. This method of packaging is simple . . . saves time . . . saves money. Protek-Sorb conquers the hazards of time, climate and distance between final factory inspection and complete consumer satisfaction.

Its successful use in war forecasts Protek-Sorb's value to the merchandising minded in the competitive times of peace.

*Reg. U. S. Pat. Off.

ARMY E NAVY
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THE DAVISON CHEMICAL CORPORATION

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Canadian Exclusive Sales Agents for PROTEK-SORB silica gel
CANADIAN INDUSTRIES LIMITED, General Chemicals Division

Progress through Chemistry

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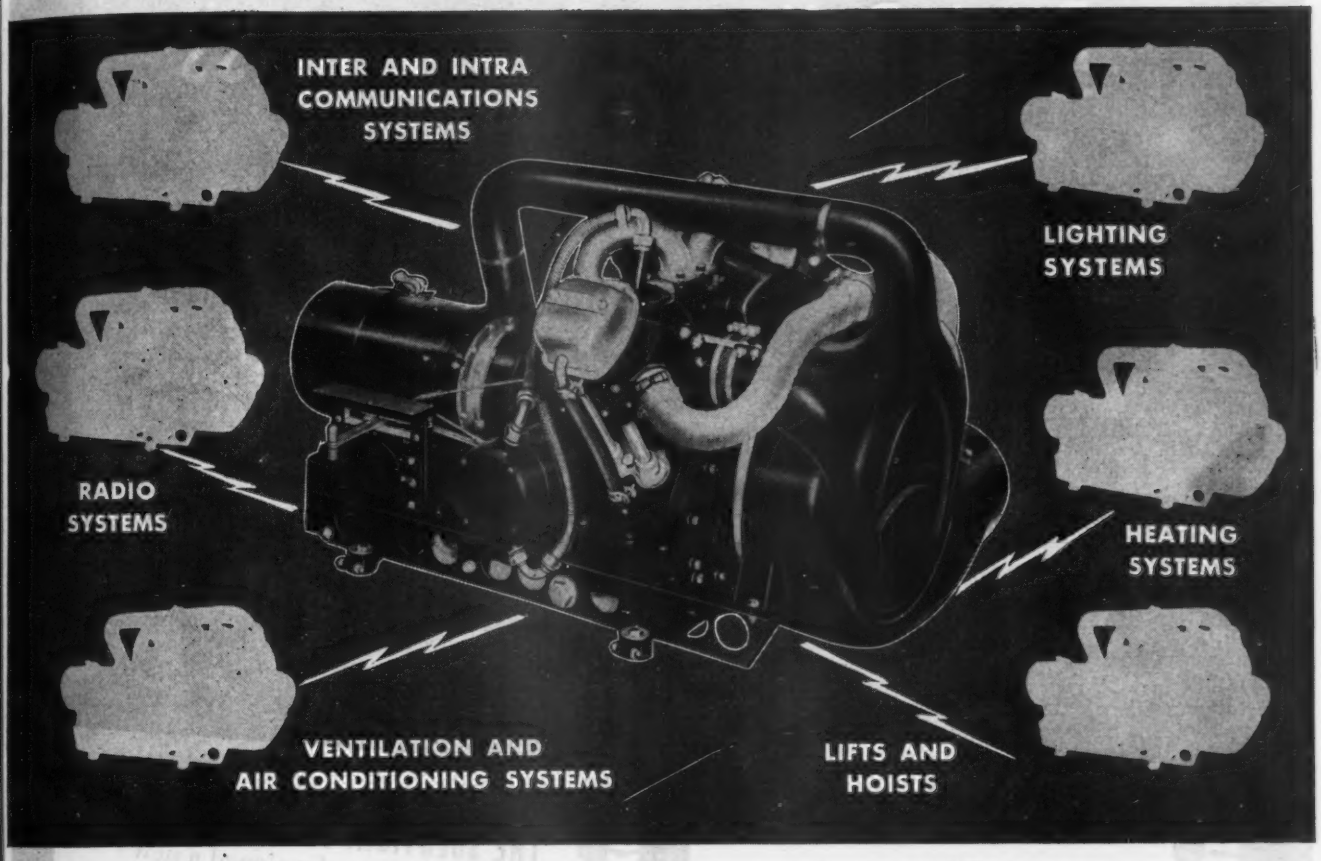
a compact, dependable AUXILIARY POWER UNIT *for your* "PORTABLE SOURCE *of* POWER"



NOW READY FOR "AFTER VICTORY" INDUSTRY

Important to "after victory" industry which will demand a small size, air cooled, portable power plant, is the Andover Auxiliary gasoline-engine Power Unit . . . 30" in length—20½" in width—16½" in height—just under 82 pounds in weight and only 116 pounds with generator and adapter for developing electrical energy.

It develops 10 H. P. rated continuous power and 15 H. P. intermittent power. The low governed speed range of 3400 to 3200 R.P.M. assures cool running, efficient and economical operation and complete dependability.

If you have need for a compact, truly portable power unit—undoubtedly the Andover Auxiliary Power Unit can be adapted perfectly to your application.

Our engineers are ready to furnish you full assistance in determining the advantages of these units in your industry.

For a descriptive booklet concerning "Andover Auxiliary Power Units"—just write us—it's free for the asking.

This auxiliary power unit is now doing Spartan service in the Boeing B-29 Superfortress and in many other multi-motored war planes.

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ANDOVER MOTORS CORPORATION • ELMIRA, N. Y.

WHOLLY-OWNED SUBSIDIARY OF ANDOVER KENT AVIATION CORPORATION

"PITTSBURGH" DEVELOPMENTS IN AIRPLANE GLASS

Bent Bullet-resisting Glass

THE PROBLEM: To supply a *bent* laminated bullet-resisting glass for use in combat airplanes where flat bullet-resisting panels are undesirable because of critical space or aerodynamic requirements.

THE SOLUTION: Pittsburgh Plate Glass Company developed a new manufacturing technique for the production of its Multiplate Bullet-Resisting Glass in bent shapes. This involved development of all basic data on armor-piercing ammunition as used on both flat and bent bullet-resisting glass, as well as the fundamental data regarding characteristics of glass as a bullet-resisting material.

A long list of developments such as this have made Pittsburgh Plate Glass Company a recognized leader in the field of laminated safety glasses for aviation use. If you would like further technical data on any aspect of the use of safety glass in airplane glazing, we urge you to write us on your letterhead, outlining your particular requirements. Address Pittsburgh Plate Glass Company, 2095-5 Grant Building, Pittsburgh 19, Pennsylvania.

"PITTSBURGH" stands for Quality Glass and Paint

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Specialists in Airplane Glass

MAKERS OF DUPLATE AND FLEXSEAL SAFETY GLASS AND OF MULTIPLATE BULLET-RESISTING GLASS

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Get Electrical Circuit Protection with KLIXON AIRCRAFT CIRCUIT BREAKERS

No matter what the flying mission or conditions, Klixon Aircraft Circuit Breakers help planes and crews to "come through" by protecting the electrical circuits from serious injury through enemy action or internal troubles.

Should the electrical circuit be jeopardized by a short or overload, Klixon Protectors trip-out the circuit preventing more serious damage. Once the trouble is corrected, the pilot merely pushes a button or snaps a switch and the circuit is re-established. Harmless transient shorts do not cause nuisance trip-outs.

Use Klixon circuit breakers on your planes. They are permanent protective devices which provide reliable electrical circuit protection. Bulletins giving sizes, ratings and performance characteristics are available on request.

KLIXON

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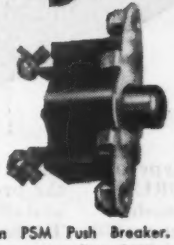
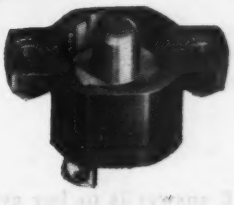
SPENCER THERMOSTAT CO., ATTLEBORO, MASS., U.S.A.

Klixon "Push-Pull" Breaker. Ratings of 5-50 amps. "Pull" feature permits opening the circuit manually at the breaker for de-energizing the circuit for service work.



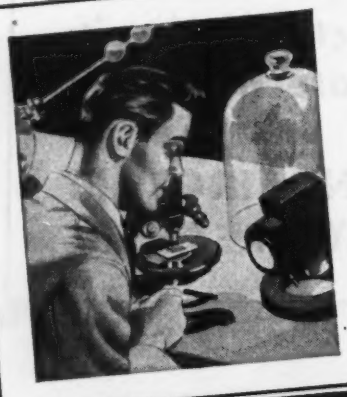
Klixon PSM Push Breaker. Same mounting dimensions as standard AN mechanical toggle switches. Ratings up to 35 amperes.



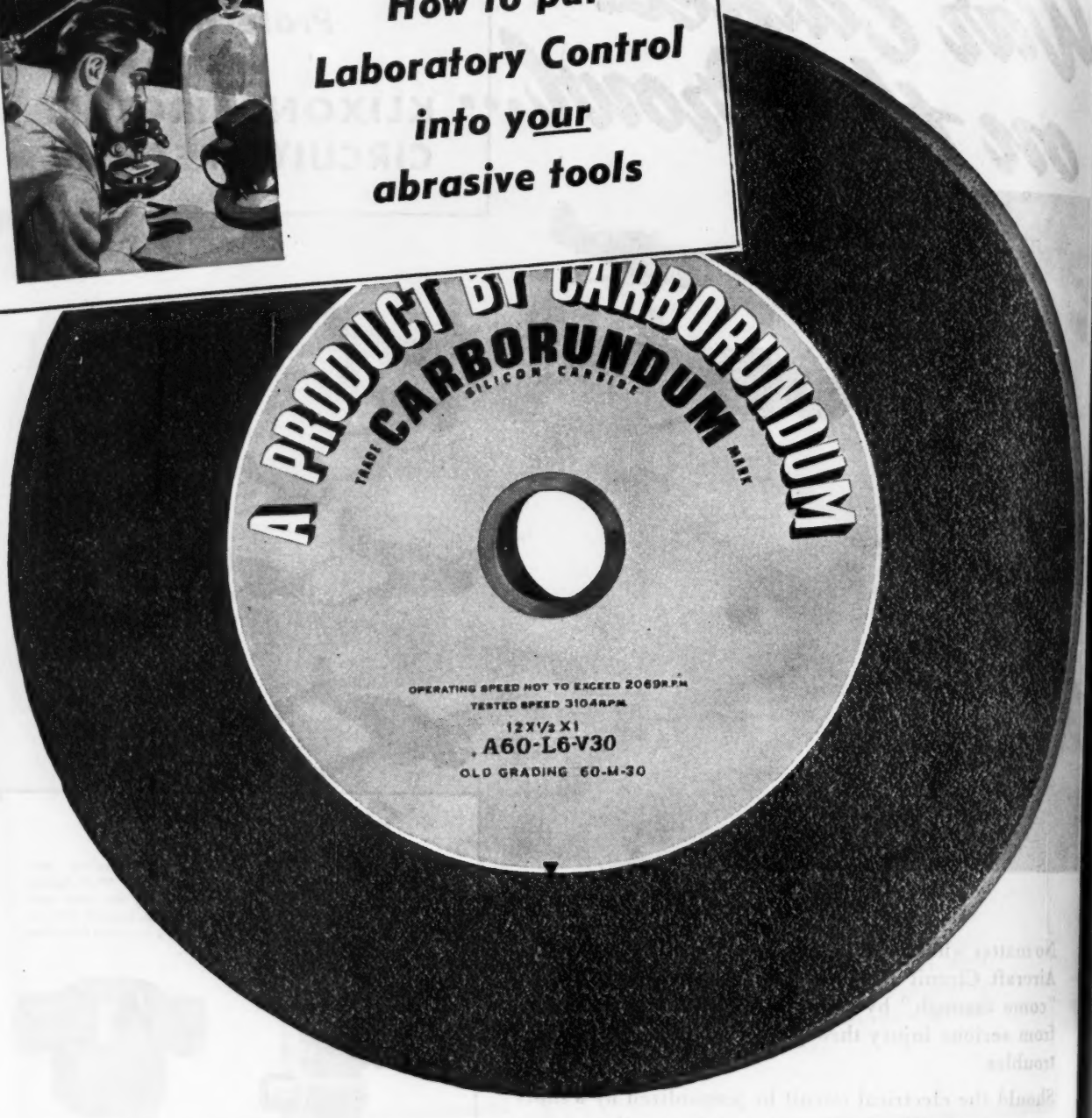
Klixon Push Breakers. PM and PLM ratings from 2 amps. through 150 amps.

Klixon Switch Breakers. C-6363 ratings from 5-35 amps. D-6364 ratings from 35 amps. through 120 amps.

Klixon Remote-Control Breaker. Available in three frame sizes with ratings from 35 amps. through 200 amps. for circuits up to 30 volts D. C.



How to put Laboratory Control into your abrasive tools



ONE answer is to buy every type of Abrasive Tool from "CARBORUNDUM"! Each ingredient in every product by "CARBORUNDUM" undergoes carefully supervised laboratory tests. This testing assures rigid control of the standards established for quality and product uniformity. Thus, you are assured that each product possesses *all* of the properties essential to a dependable and efficient abrasive tool.

To help you obtain the most efficient operation under even the most difficult conditions, the services of the "CARBORUNDUM" Abrasive Engineers are at your disposal. These men are thoroughly familiar with the proper application of grinding wheels, coated abrasives, abrasive grain, sticks, and "MX" products. For the correct solution to *YOUR* abrasive problems consult a "CARBORUNDUM" representative.

The Carborundum Company, Niagara Falls, N. Y. . . . . Distributors in Principal Cities.

THERE IS A PRODUCT BY

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TRADE MARK

FOR EVERY ABRASIVE APPLICATION

("CARBORUNDUM" and "MX" are registered trade marks of and indicate manufacture by The Carborundum Company)

SEXTUPLE THREAT

Official Photo U. S. Air Forces

Wrapped up in one formidable package are the lessons of five years of attack bombing. The brilliant new Douglas Invader is America's fastest, most versatile bomber. It is designed to carry such an extremely flexible selection of machine guns, cannon, bombs, and fuel that its offensive striking power is adaptable to almost any combat situation.

This sleek "war-shortener" is making its presence felt wherever the going is toughest — more power to it.

To us at Chandler-Evans — men and women together — it is a proud feeling to know that CECO fuel pumps are among those chosen for this superb new fighting machine. We are leaving no stone unturned to justify this trust.

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CHANDLER-EVANS CORPORATION

SOUTH MERIDEN
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Continental-Diamond
Engineered Dielectric Materials

A grade LE DILECTO laminated plastic insulating part used in rocket controls. Its insulating properties and dimensional accuracy must remain stable under terrific impact and vibration and regardless of temperature extremes.

THE ability of C-D DILECTO Electrical Insulation to take all a rocket can give . . . and still function perfectly . . . is good evidence that C-D DILECTO will serve well as electrical insulation in your present and future products.

C-D DILECTO is made in many standard grades to meet specific electrical, physical and thermal problems. Special grades can be developed to meet unusually exacting conditions. C-D DILECTO may be the solution to your "What Material?" problem.

KR-45

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The Plastics

DILECTO—A Laminated Phenolic.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

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DIAMOND Vulcanized FIBRE
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MICABOND—Built-Up Mica Electrical Insulation.

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Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

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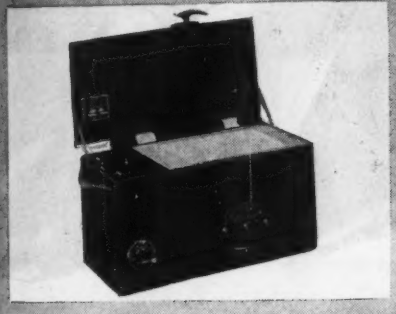
Choose the size to fit your **REPRODUCTION** needs

AVAILABLE SIZES

DATA FOR ENGINEERING

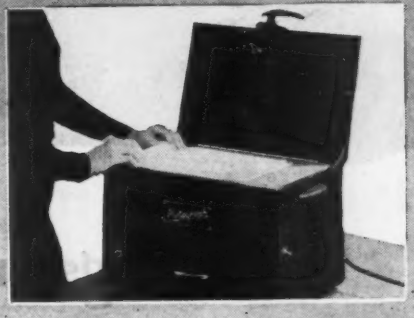
42" wide — in any length is the reproduction capacity of the G-13 Continuous Rotary Portagraph (left). Unsurpassed for making photo-copies of drawings, tracings, maps, blue-prints and for handling large volume copying.

30" x 40"—the G-12 Vacuum Seal Portagraph (right) is a dependable and indispensible piece of engineering office equipment. Ideal for making contact prints of anything written, printed or drawn. Also made in 40" x 60" size.



9½" x 15"— The G-10 Portagraph has innumerable everyday uses in engineering and other offices. Portable—can be set up anywhere. Electrical timing switch insures uniformly fine reproductions. For use with roll paper or cut sheets.

20" x 24"—Contact photo-copies are quick, easy, inexpensive to produce on the G-11 Portagraph. Electrical micro-matic timing switch insures perfect results with inexperienced operators.



Model G-9—size 9½" x 15"—equipped with manual timing control. An efficient general-purpose, low-cost unit, easy and simple to operate. Will copy from single page or bound book.

From these five sizes of Portagraph, it's a simple matter to select the model that exactly fits your individual needs. Each operates on the contact principle using paper, tracing cloth or vellum, or film. All operate simply and efficiently without the need of a dark room.

A photocopying machine that reproduces exactly what it sees with no chance for human error, Portagraph is ideal for copying tracings, sketches, blueprints—in fact anything written, printed or drawn.

Easy to operate, even for inexperienced personnel, Portagraph reduces the costly time and labor required in manual copying or tracing—and eliminates subsequent checks and proofreading for accuracy.

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"How to Reduce Costly Manual Tracing, Drawing and Copying" contains many time-saving, labor-saving ideas for the engineering office. This helpful 20-page book of practical information is available free of charge from our nearest Branch Office. Phone, write or wire for a copy.

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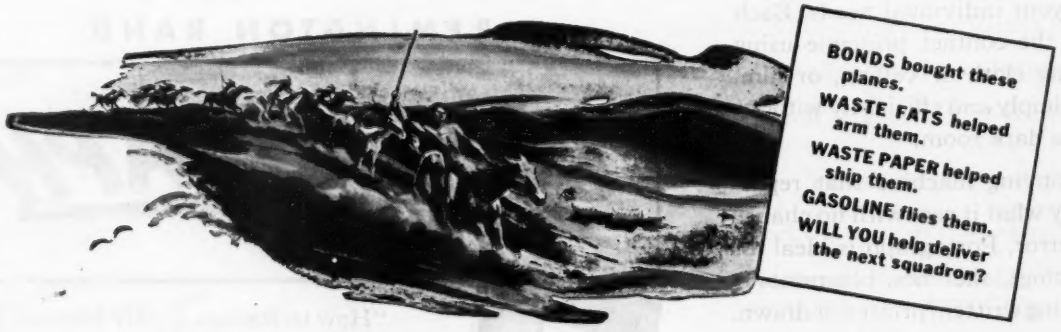
Mustangs on the Warpath

The forward element is peeling off. The other half of the squadron will fly formation during the attack, providing top cover. That's how P-51 Mustangs take to the warpath over Burma. And what a hunting ground it has been. Hunting with everything from bazookas to 500 pound depth charges and 1,000 pound demolition bombs, Mustang pilots have forced the Jap in Burma to move furtively at night and to hide in the jungle during the day.

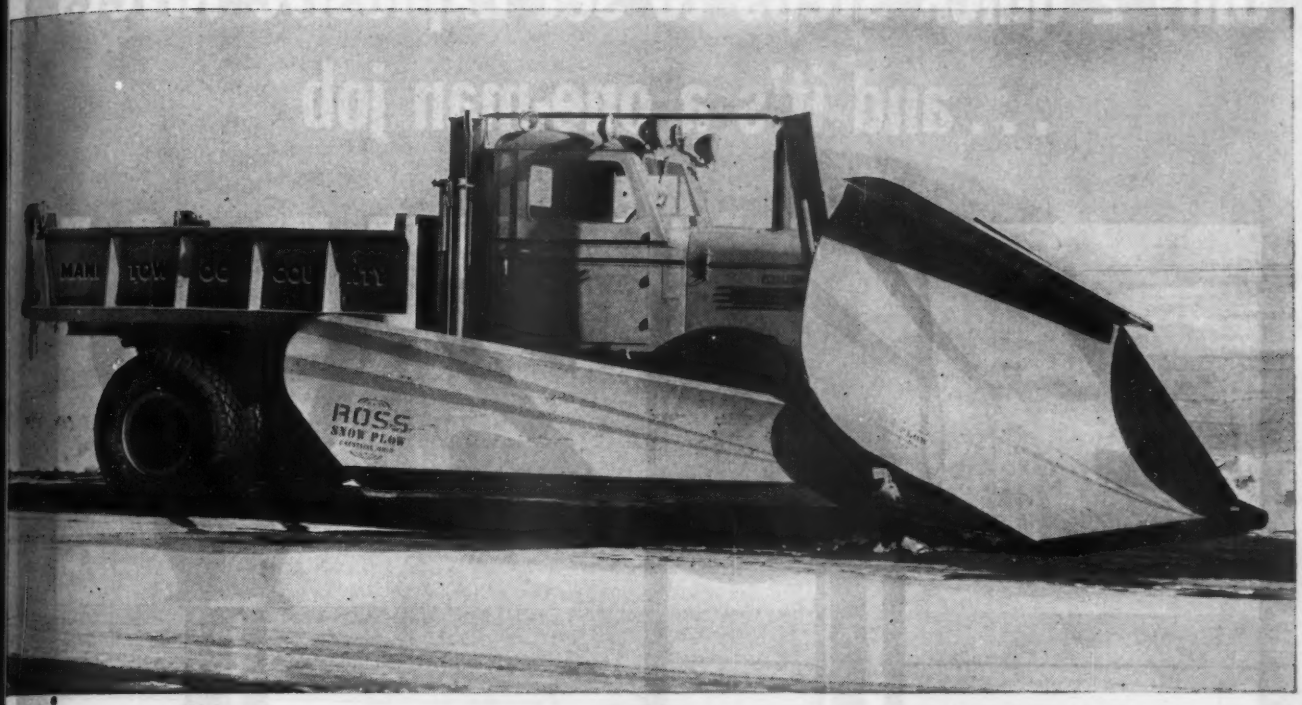

BONDS bought these planes.
WASTE FATS helped arm them.
WASTE PAPER helped ship them.
GASOLINE flies them.
WILL YOU help deliver the next squadron?

Like its famous namesake the P-51 Mustang is tough, hard-hitting and elusive.

North American Aviation *Sets the Pace*

PLANES THAT MAKE HEADLINES... *the P-51 Mustang fighter (A-36 fighter-bomber), B-25 and PBJ Mitchell bomber, AT-6 and SNJ Texan combat trainer. North American Aviation, Inc. Member, Aircraft War Production Council, Inc.*

OSHKOSH 4 WHEEL DRIVE



OSHKOSH EQUIPMENT NOW AVAILABLE to Highway Departments and Airports

WITHOUT slowing up our deliveries to the armed forces, we are authorized to produce a limited number of trucks for essential civilian use. Snow removal units are now being delivered to State and County Highway Departments and to Airports.

With its twenty-seven years of four-wheel drive engineering, Oshkosh equipment provides efficient power, rugged durability and economical operation for snow removal, maintenance and heavy construction work.

Write for descriptive literature

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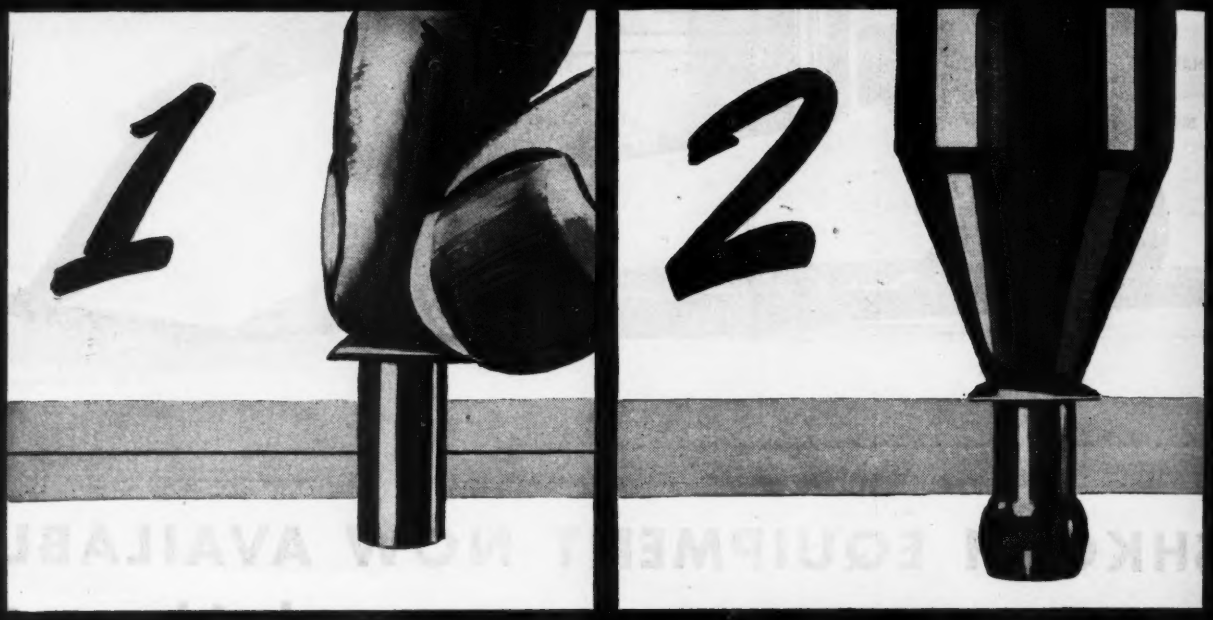
Only 2 quick steps to set Explosive Rivets . . . and it's a one-man job



1. Insert rivet in hole.

2. Apply heated iron to rivet head.

FOR BLIND RIVETING . . . definitely! But, in addition, *wherever* there's a job that's hard to reach, Du Pont Explosive Rivets may save time and reduce costs.

Today, aircraft manufacturers are using Explosive Rivets on many jobs formerly finished with conventional rivets. Spots that are hard to get at . . . places where design, intricate wiring or bulky instruments interfere with bucking bars . . . awkward locations inside the fuselage, wings and stabilizers . . . these and many more are "naturals" for Explosive Rivets.

Get complete information. Write for helpful manual giving all the details. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington, Delaware.

Push-fit holes are not necessary. Explosive Rivets have a charge extending the full length of the shank (*Above*). When fired (*Right*) the entire shank expands . . . completely fills the hole and provides a strong, tight joint. The barrel-shaped blind head locks the rivet securely in place . . .

DU PONT EXPLOSIVE RIVETS

the only one-piece blind fastener

DU PONT

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ANOTHER MASS-PRECISION ASSEMBLY BUILT BY NICHOLS

LUBRICATING THE TURBOSUPERCHARGER

If you could look in on a turbosupercharger in flight, you would marvel at its performance. Picture an 18″ shaft revolving at 22,000 RPM while exposed to *plus* 1500° from the engine's exhaust at one end and to the substratosphere's *minus* 67° at the other. Consider the problem of lubricating the turbosupercharger's bearings under such challenging conditions.

That's the job for the self-contained, double-unit pump developed and built by W. H. Nichols and Sons on an interchangeable parts and assembly basis.

To meet both performance and cost requirements large-scale production of this unit necessitated simplified design. Nichols engineers blueprinted a pump that had a simple seal, no ball bearings, only three shaft diameters and two shoulders. *Mass-precision* techniques followed through with "split-tenth" accuracy in each component part and avoided costly, step-by-step inspection. Despite the close fits, *all parts are assembled without pre-selection.*

The same ingenuity for precision manufacture on a mass-production basis has solved other equally difficult problems for over forty years. Here unique facilities have been developed for producing the "hard" parts. They may be your answer for working out that post-war product. Let "Accurate" Nichols help you see it through.

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"Accurate" *Nichols*

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

America's Superfortresses deal deadly destruction to Japanese war plants because felt—in many forms—rides hostile skies with them. In greater safety and comfort—crew members do a better job, thanks to felt which seals "pressurized" cabins, guards precious instruments against vibration, deadens motor sound, insulates against cold . . . and serves as gaskets, washers, lubricating wicks, etc.

For many purposes only felt can meet specifications that demand flexibility, resilience, compressibility, resistance to water, oils, heat and age—plus sound deadening, heat or cold insulation and other properties, Western Felt is adaptable to a wide variety of uses . . . It is processed from wool-soft to rock-hard . . . and may be finished to surprisingly close tolerances.

A Western Felt Works engineer will gladly tell you the full story of felt's use in the modern plane and to suggest how it might be applied in your production process or product. Write us today!

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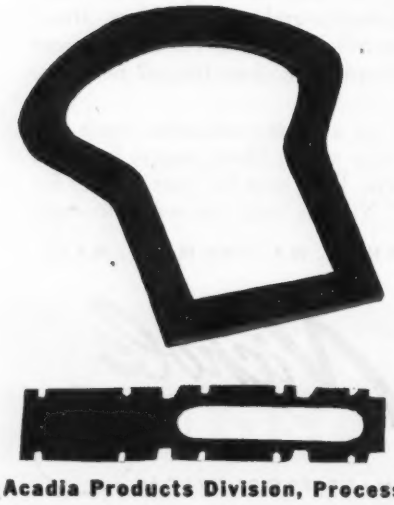

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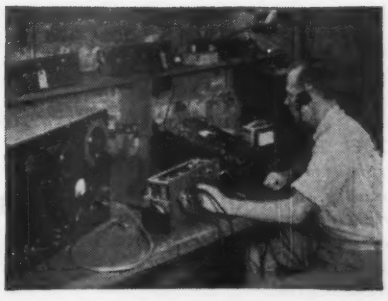
Largest Independent Manufacturers and Cutters of Wool, Hair and Jute Felt

Acadia Products Division, Processors of Synthetic Rubber and Plastics: Sheets, Extrusions and Molded Parts

POINTING THE WAY IN AVIATION COMMUNICATIONS

DESIGNING



ENGINEERING

MANUFACTURING

• United Cinephone Corporation spent its pre-war years successfully solving manufacturers' problems by the application of Electronic Devices ... We are now meeting the demands of the armed services and have extended our facilities many times.

This experience coupled with increased facilities will continue to function in pointing the way to the solution of postwar aircraft, electronic and communication problems.

Address all inquiries to
Applications Engineering Department

We now invite inquiries from manufacturers in connection with the development and production of all types of electronic and communication equipment for the aviation industry.

MODEL BRT AIRCRAFT TRANSCEIVER
A typical military product of
UNITED CINEPHONE CORPORATION

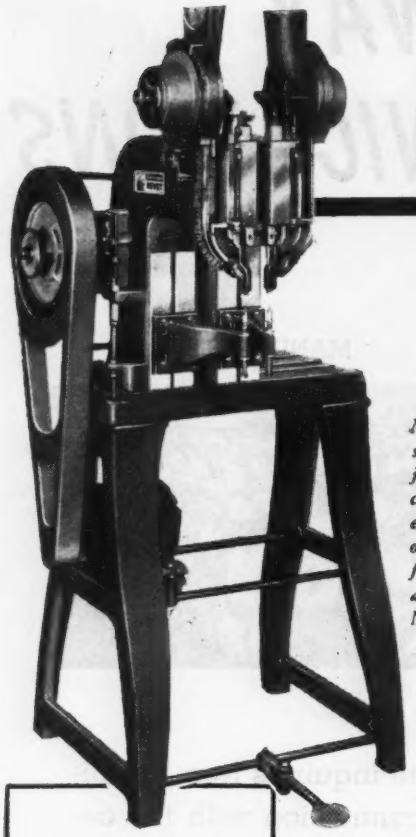
UNITED CINEPHONE CORPORATION

TORRINGTON, CONNECTICUT

Chicago AUTOMATIC RIVETING

INCREASES OUTPUT

Ten to Twenty Times!

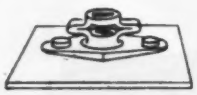


MODEL 72
Multiple rivet setter with adjustable riveting centers to set rivets close together or well apart. Also for Dzus Springs and Elastic Stop Nut Plates.

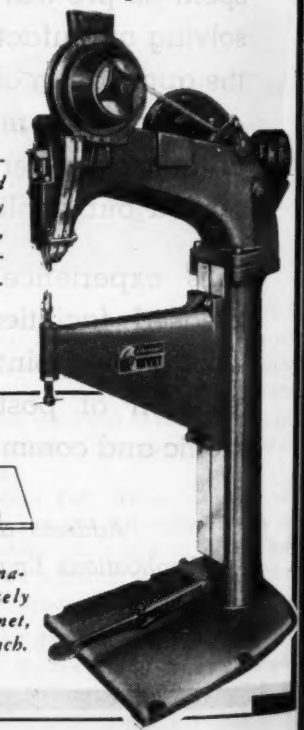
By changing from hand feeding and insertion of the rivet to Chicago Automatic Rivet Setting, many manufacturers *conservatively* estimate they have multiplied each riveter's output ten times. Actually, in hundreds of sub-assembly operations, the use of Chicago Automatic Riveting Machines and Tubular Rivets has increased the production of individual workers *twenty times!* And so simply are these manpower-saving machines operated that the usual schooling of inexperienced operators is unnecessary.

The speed of Chicago Automatic Riveting Machines lies in their completely automatic operation. Precision tubular or aircraft rivets are fed, inserted and clinched with each release of the foot pedal. The machines are easily adjusted in a few minutes to handle different sizes of Rivets. And whether it is a single or multiple type Chicago Rivet Setting Machine, whether it has a 45-inch throat, or a 6-inch throat, it clinches grommets and eyelets, and inserts drive screws as efficiently as it sets rivets.

Fully approved by Army and Navy engineers, far faster in production, effective both in saving vital manpower and cutting production costs, it is little wonder that the aircraft industry is depending more and more on Chicago Automatic Riveting.



Will fasten both ends of a Dzus or similar spring with one stroke. Also sets in one operation the two rivets necessary to hold an elastic stop nut plate, or anchor nut in position.



MODEL 140
with interchangeable rivet hopper and raceway assembly also Feeds, Inserts, Clinches Dzus Fasteners and Grommets.

Fastener is permanently but loosely inserted in grommet, completing the clinch.

Chicago Rivet

CHICAGO RIVET & MACHINE CO.

9616 West Jackson Boulevard, Bellwood, Illinois (*Chicago Suburb*)

Our Post-War Policy in one word*

"AVIATION!"

The Doak organization was born in aviation of aviation long before Pearl Harbor. All of our key personnel have at least 15 years experience in aircraft production. We believe in aviation. It is the most dynamic force in transportation today.

We, therefore, are not thinking or planning in the usual conversion or "reconversion" terms. We believe that the industry is going to need more than airframe manufacturers in the competitive era; that it will need men with specialized skills and specialized machinery.

The Doak plant is a self-contained metal working factory, with complete processing departments. We entirely manufacture in our own plant complete parts and assemblies which now fly on all fighting fronts with our airmen.

E. R. Doak

E. R. DOAK, President

DOAK AIRCRAFT CO., INC.
TORRANCE, CALIFORNIA

*WE DO NOT INTEND TO MANUFACTURE REFRIGERATORS, VACUUM CLEANERS, ROWBOATS, CAN OPENERS OR EGG BEATERS.

AIRCRAFT WIRE PRINTER

DESIGNED BY AIRCRAFT ENGINEERS

TO MEET ARMY-NAVY REQUIREMENTS

Developed by Tool Design Engineers of Glenn L. Martin Company and built by York Electric, manufacturers of standard Wire and Cable Printers. Our Wire and Cable Printers now in operation in leading wire manufacturing plants.

Specialists in manufacture of Wire and Cable printing devices for years. Wire Printer now offered the aircraft industry incorporates the engineering experience thus gained.

A thoroughly tested Wire Printing Machine. Wire immersed in gasoline and oil for one hundred hours without damage, passing Army and Navy tests.

Equipped with movable hand cut brass, or standard foundry type, new codes and symbols are instantly available.

The code wire marker you will eventually buy. Avoid disappointing experiments with untried makeshifts.

NOT A TOY—NOT AN EXPERIMENT

It was natural for York Electric to make the first practical hot stamp wire printer for aircraft wire identification used at Glenn L. Martin plant that automatically prints miles of wire.

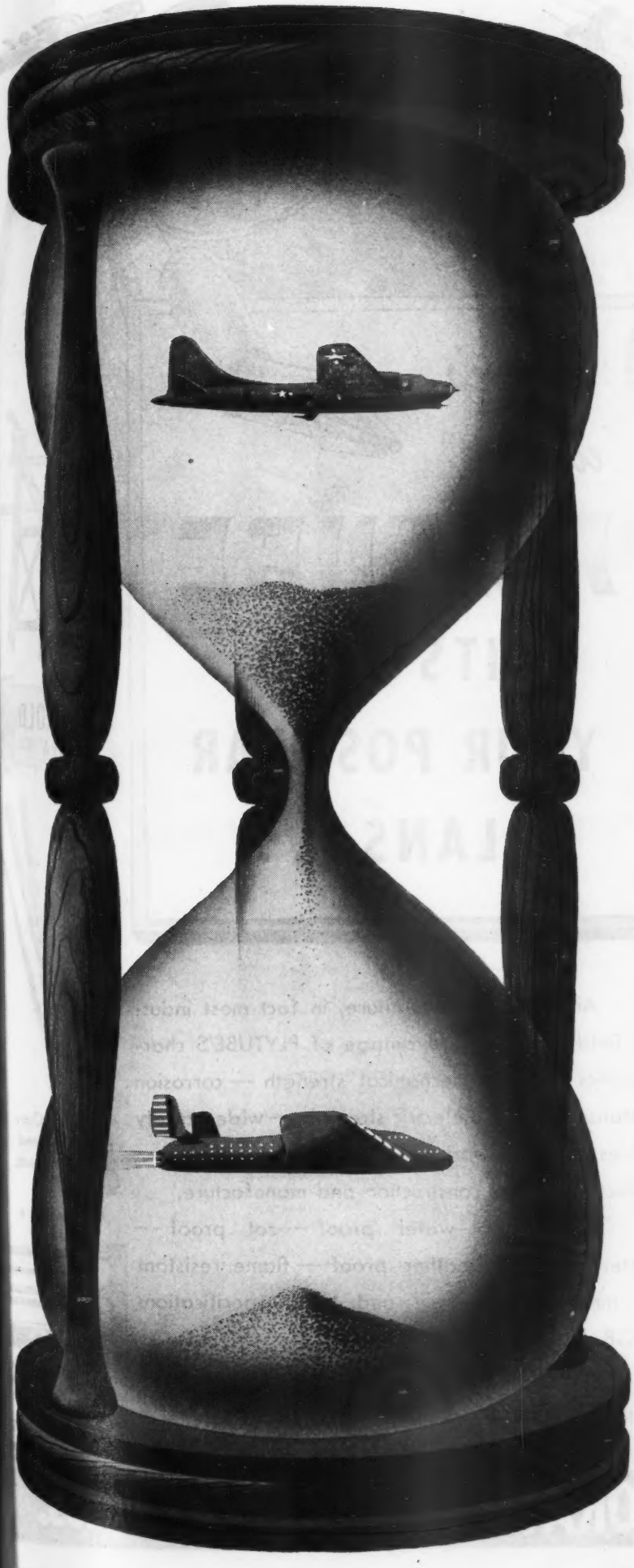
Easily meets the Wright Field wire specification 32310A, amendment No. 4, Nov. 11, 1942.

Thermostatic controlled heated type, prints clear, legible identification on No. 22 to No. 0 wires.

This rugged York Electric Wire Printer built to give years of service. "Bugs" eliminated. Aircraft Industry now presented with wire printer engineeringly correct.

YORK ELECTRIC TOOL COMPANY

52 SO. DUKE ST., YORK, PA.



WILCO facilities Expanded to Meet Wartime Needs!

But Postwar Industry will be the ultimate gainer from the many new WILCO products and developments

As the Hourglass indicates . . . at the coming of peace, the skill and experience gained in the development and application of new WILCO products and techniques will mean much to automotive, electrical appliance and many other types of manufacturing customers.

Though now chiefly applied to the war effort, these new WILCO developments are destined to play as vital a role in the postwar industrial "comeback" as they are now playing in scores of wartime applications.

Thermostatic Bimetals, Electrical Contacts, and Precious Metal Bimetallic Products are such important factors in the precision performance of ships, planes, tanks, guns, and various instruments of the Army and Navy that the H. A. Wilson Company has found it necessary to enlarge its facilities and develop these important new products and techniques.

In the postwar period no company will be better equipped to meet individual requirements for Thermostatic Bimetals and Electrical Contacts on any desired scale than the H. A. Wilson Company, pioneers in this field.

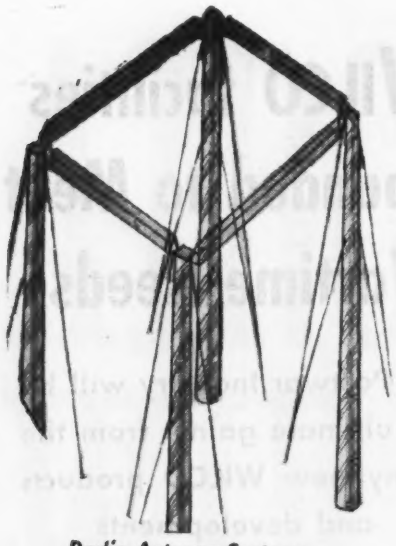
WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel*—for bearings, shims, reflectors, *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. *Silver Clad Steel. Rolled Gold Plate.* Special Materials.

THE H. A. WILSON COMPANY

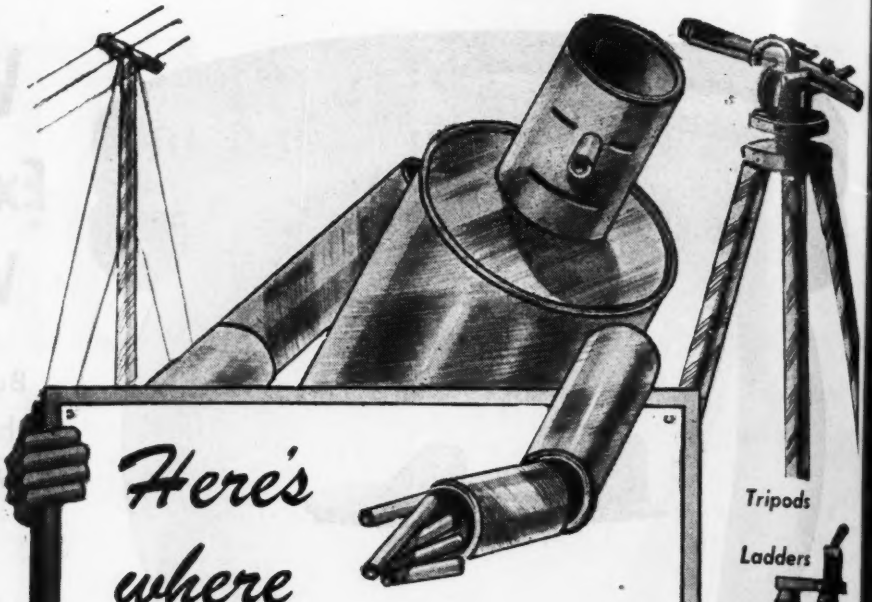
105 Chestnut Street, Newark 5, New Jersey

WILCO

Thermometals—Electrical Contacts
Precious Metal Bimetallic Products



Radio Antenna Systems



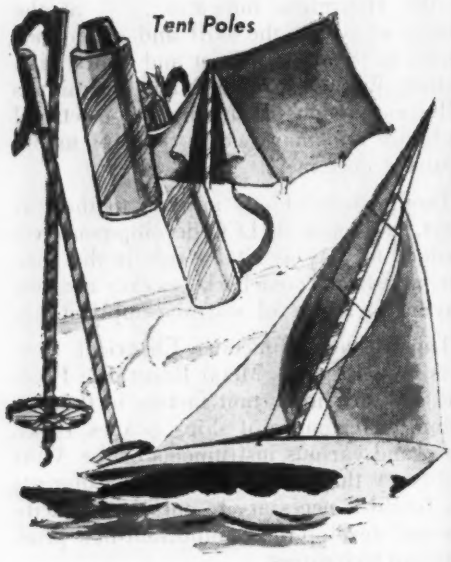
Tripods

Ladders

Here's where

PLYTUBE

FITS INTO YOUR POSTWAR PLANS . . .



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Thermos Bottles · Quivers
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Maintenance Stands

Aircraft, radio, furniture, in fact most industrial fields can take advantage of PLYTUBE'S characteristics of high mechanical strength — corrosion resistance — high dielectric strength — wide variety of sizes and easy work ability in improving their own product in design, construction and manufacture.

PLYTUBE is water proof — rot proof — splinter proof — weather proof — flame resistant and meets U. S. Army and Navy specifications AN-G8 or AN-NN-P511b.

Write today and we will be glad to help you adapt PLYTUBE to your specific requirements.

PLYMOLD CORPORATION Lawrence, Mass.

A peacetime plane that was "built to order"

FOR THOUSANDS OF AMERICANS

Easy to Fly . . . Easy to Own . . .

THOUSANDS have answered the popular Bellanca Aircraft Quiz, and still the returns roll in! They show increasingly that The Bellanca Cruisair, as produced prior to the war, approached the ideal peacetime personal plane that America's flying public has in mind.

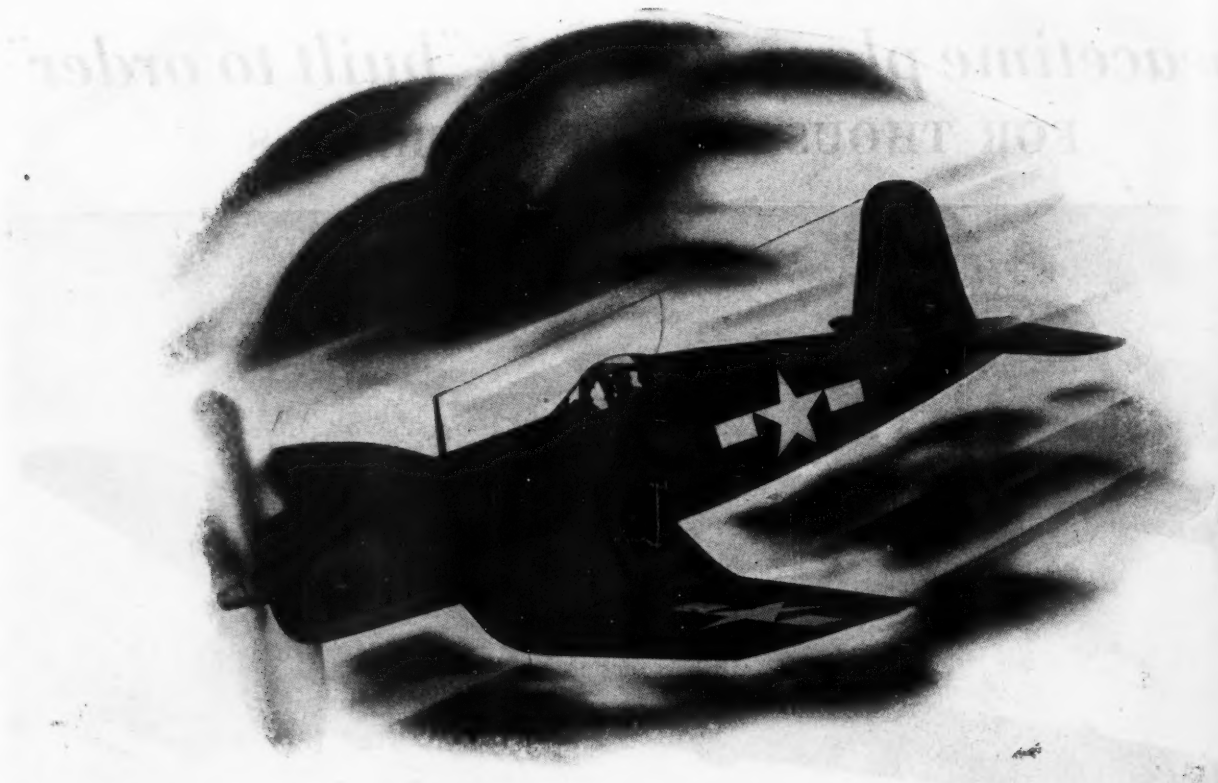
The leading answers indicate that the flying public wants a three to four place low wing monoplane with retractable landing gear, equipped with a 120 to 150 hp air-cooled opposed engine and gross weight in the 1500-2000 lb. bracket — all features which the Bellanca engineering organization had anticipated and incorporated in the pre-war Cruisair. The Cruisair's top speed of 150 mph, cruising speed of 130 mph, and landing speed in the 40-50 mph range come within the performance preferences expressed by the majority. Typical Bellanca efficiency provided extreme economy of operation—22 miles per gallon of fuel, at better than two miles per minute cruising speed.

The Quiz returns are voluntary—they give a pattern of the ideal specifications and requirements of the airplane which will most closely approach the desires and wishes of the majority! These results indicate that The Bellanca Cruisair was practically "built to order" for the thousands who are now planning their post-war flying.

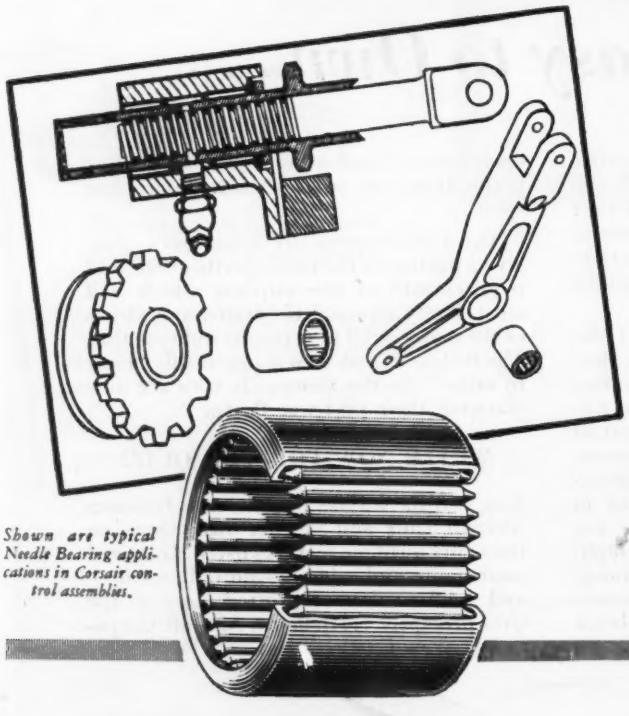
WRITE NOW FOR THE QUIZ!

You still have time to enter the Bellanca Aircraft Quiz and register *your* views on the many airplane features listed. Just send your name and address—no obligations—and we'll mail your printed copy of the Quiz promptly. . . . Bellanca Aircraft Corporation, New Castle, Delaware. Dept. S 3.

The BELLANCA *Cruisair*



Needle Bearings Provide Anti-Friction Ease in Manual Controls of Vought Corsair



Shown are typical Needle Bearing applications in Corsair control assemblies.

Fast, smooth operation is a "must" in the design of aircraft controls. To assure complete anti-friction ease at such points, designers of the famous Vought Corsair specified the use of Torrington Needle Bearings—the *only* anti-friction bearings found to meet space, weight and operating requirements.

You, too, will find where space, weight, load capacity, stability and the ease of anti-friction operation are important factors, the application of Torrington Needle Bearings frequently offers the best solution to design problems.

Investigate for yourself how the anti-friction advantages of Torrington Needle Bearings can be of assistance in your product planning. Details will be found in Catalog No. 30-A. Send for your copy today.

THE TORRINGTON COMPANY
TORRINGTON, CONN. · SOUTH BEND 21, IND.

New York Boston Philadelphia Detroit Cleveland Seattle
Chicago San Francisco Los Angeles Toronto London, England

TORRINGTON NEEDLE BEARINGS

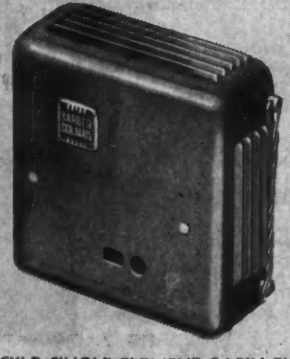
BARBER-COLMAN

MICRO CONTROLS

For Aircraft Applications

Barber-Colman MICRO Control equipment is *especially designed and built* for aircraft service. Note light weights, small sizes, and high torques indicated by brief specifications here. Note also the clean lines and compact construction, characteristic of modern aircraft equipment. Barber-Colman Controls have proved their ability to perform accurately, reliably, and efficiently in leading lines of military aircraft now in service. With many conversion jobs coming up, they are worth considering now in order to provide automatic control of CABIN TEMPERATURE . . . ANTI-ICING TEMPERATURE . . . CARBURETOR AIR TEMPERATURE . . . CARBURETOR MIXTURE . . . CARBURETOR THROTTLE. Write today for further information on the units shown here and other Barber-Colman Controls designed for aircraft service. Look for Barber-Colman equipment in the air-liners of tomorrow!

Type EYLD REMOTE BULB THERMOSTAT. Weight, including bulb and tube, 1 lb. 2 oz. Dimensions, 3-1/4" x 3-1/2" x 1-5/16".



Type CYLD SINGLE ELEMENT CABIN THERMOSTAT. Weight, 7 oz. Dimensions, 3-1/4" x 3-1/2" x 1-5/16".

Type DYLD DUPLEX CABIN THERMOSTAT. Weight, 17 oz. Dimensions, 6" x 3-1/2" x 1-5/16".

Type FYLC CONTROL MOTOR. Maximum torque, 50 lb. in. Approximate weight, 2-1/4 lbs. Available with or without right-angle drive.

Type BYLC CONTROL MOTOR. Maximum torque, 500 lb. in. Weight, 3 lbs. 4 oz. Available with or without right-angle drive.

BARBER-COLMAN COMPANY

ROCKFORD • ILLINOIS

PRECISION UNBRAKO SAFETY

INTERNAL WRENCHING BOLT

100° FLUSH HEAD SOCKET BOLT

(National Aeronautical Standard)

INTERNAL WRENCHING LOCK NUT

FIG. 1

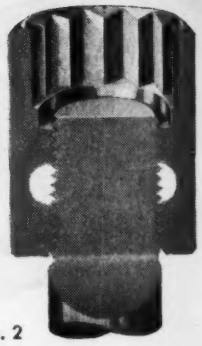


FIG. 2

Our INTERNAL WRENCHING BOLT (A) and 100° FLUSH-HEAD SOCKET BOLT (B) fully meet the high degree of precision demanded by the aviation industry. They are made to tolerances so extremely close as to be practicable only by our long and extensive experience in precision work. Designed expressly by and for the aviation industry, these bolts have the famous "Unbrako" qualities of strength and accuracy, while due to their internal wrenching feature they facilitate compact designs, thereby saving material, weight and space.

The "UNBRAKO" INTERNAL WRENCHING LOCK NUT is a safety nut for primary connections in aircraft—officially approved. Combining thorough "fool-proofness" with ample load-carrying capacity, the "Unbrako" Lock Nut achieves an absolutely dependable locking grip by means of two vulcanized fibre plugs (Fig. 1) inserted through the body of the nut. Fig. 2 shows how these plugs contact four threads of the bolt, gripping it firmly.

Heat-treated to a high degree of Rockwell hardness, the "Unbrako" can be used almost indefinitely before the torque falls below the Wright Field minimum.

OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 566

BRANCHES — BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

It's REPLACEABLE Joe!

The valve can be fixed in a few seconds. That's good news to men responsible for "keeping 'em rolling and fighting"

Suppose G.I. Joe's valve was the Schrader Valve of 50 odd years ago *without* today's removable, replaceable parts! He would have to dismount his tire and tube and vulcanize an entire *new valve* on his tube to repair it!

Compare this with the modern Tire Valve Equipment. In the event of any possible damage of tire valve sealing parts, he can make a complete change of cap and core in less than a minute. Think of what that means to the mobility of our troop movements which today counts on split second timing! One standard size of cap and core is interchangeable in the standard valve in any pneumatic tire on any vehicle—the smallest, lightest, quickest type of service stock—an advantage which supply experts, in and out of the Armed Forces in all parts of the world, appreciate.

As time goes on, the parts of any valve wear. Abuse, grit and age cause any valve to lose its 100% efficiency. The experience of many years, plus billion after billion of miles—week after week, of actual performance on trucks, cars, cycles, have proved this to be true. But due to foresight of the tire, automotive and valve industries, the tire valve can be restored to its original efficiency by merely inserting a new core and applying the standard cap. The Schrader Valve Cap is guaranteed airtight up to 250 lbs. pressure.

A copy of "How to Prevent Roadside Flat Tires," an explanation of the Comparative Air Loss System, as described in the Office of Defense Transportation Bulletin, is available from Schrader upon request.

A. SCHRADER'S SON, *Division of Scovill Manufacturing Company, Incorporated,* **BROOKLYN 17, NEW YORK**

Buy More War Bonds

. . . An Ideal of Quality reflected in a Name

For years the divisions of Allied Products Corporation have held proudly to an ideal of quality. Through two wars its craftsmen have produced the finest in precise production tools.

Because of this ideal, Allied has become a standard source of supply for many mass production industries. Now, because of wartime expansion, Allied is equipped to serve more manufacturers than ever before. Anticipate your postwar requirements and start now to profit by Allied's years of experience and exceptional facilities. A good beginning is to check your supply problems with Allied. Send blueprints for estimates or write today.

"IT'S AN ALLIED PRODUCT" . . . Allied Products Corporation and its divisions, Richard Brothers and Victor-Peninsular, in Detroit and Hillsdale, Michigan, make: cold forged parts, hardened and precision ground parts, cap screws, sheet metal dies (from the largest to the smallest), R-B interchangeable punches and dies, steam-heated plastic molds, jigs and fixtures and special production tools.

ALLIED PRODUCTS

CORPORATION

Department 18, 4614 Lawton Avenue, Detroit 8, Michigan

"Aero-Seal" HOSE CLAMPS

STAINLESS STEEL

Where service conditions require highest corrosion resistance, these *all-stainless-steel* clamps should be used. They incorporate all the basic superior features of AERO-SEAL design plus some distinctive engineering advantages such as *non-welded saddle*, greater strength, greater flexibility, and slightly less weight than their carbon steel counterparts. They will soon be available in all nominal sizes from 1/2" through 4 1/4". Let us know your needs *now*, so we can advise you as accurately as possible on the scheduling of future deliveries.

CARBON STEEL

Selected, heat-treated carbon steels, finished in high-grade cadmium plate for rust resistance, go into the making of these AERO-SEAL Hose Clamps. Millions of these clamps are in strenuous active service and have achieved the widest acceptance under the strict requirements of Army-Navy Specification AN-FF-C 406a. Manufacturing facilities for all sizes in the full range are now functioning adequately so that orders can be scheduled for near-future delivery or as needed. We urge that you advise us of your future requirements *now* so that we can take care of your needs as promptly as possible.

- HIGH STRENGTH
- UNIFORM PERIPHERAL TIGHTENING
- NO LEAKAGE UNDER HIGH PRESSURES
- SELF-LOCKING, NO LOCK WIRE NEEDED
- CAN BE PUT ON HOSE IN PLACE
- NO LOOSE PARTS
- CAN BE RE-USED
- WILL NOT DISTORT OR COLLAPSE THIN-WALL TUBING
- COMPACT DESIGN
- FULL RANGE OF SIZES
- EXTRA LONG TAKE-UP

AIRCRAFT STANDARD PARTS CO.
1715 NINETEENTH AVE., ROCKFORD, ILLINOIS

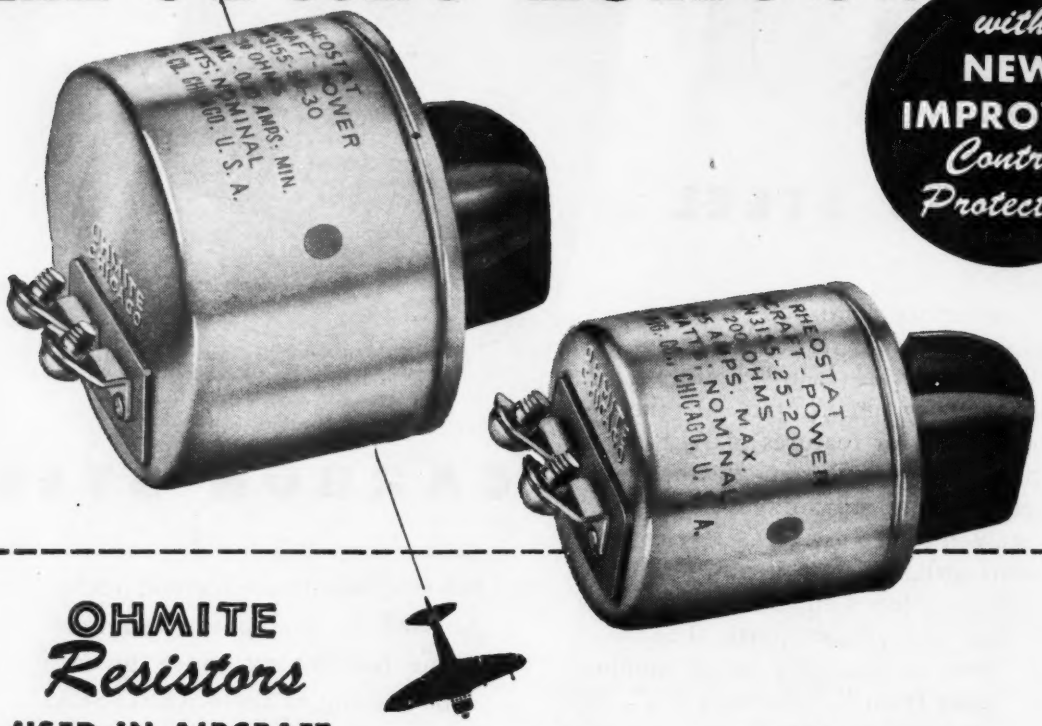
AIRCRAFT Standard PARTS CO.

WE ORIGINATED the AERO-SEAL Worm Drive design and thus offer you the background of longest experience in the manufacture of this new and better type of hose clamp.

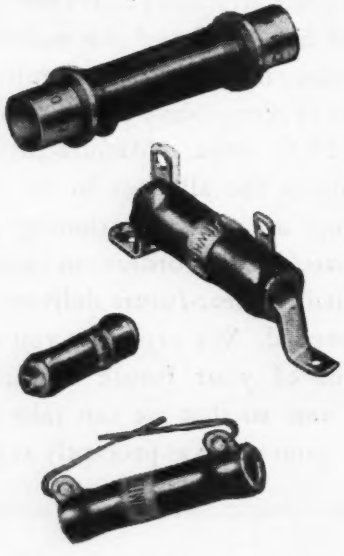
OHMITE NEW AN3155 (AN-R-14a)

Aircraft Rheostats

with **NEW IMPROVED** *Control Protection*



OHMITE *Resistors* USED IN AIRCRAFT



Ohmite Rheostats have long been standard on aircraft. Today, these new AN3155 units provide new improved control protection and other new features. They assure smooth, close, dependable control under every service condition of heat, cold, humidity, altitude, shock and vibration.

Made in 25 watt and 50 watt sizes—linear or taper wire-wound—in various resistances—with "off-position" as required by the specification. Totally enclosed in a unique, corrosion-resisting metal enclosure. Lighter in weight than the allowable weight specified. *Write for details.*

OHMITE MANUFACTURING COMPANY
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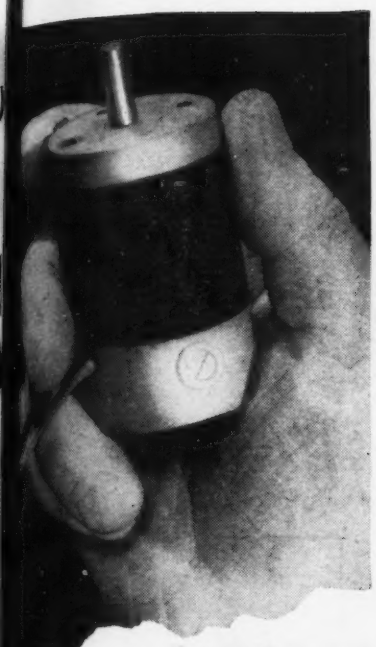
Be Right with **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES



IT PACKS A BIG PUNCH

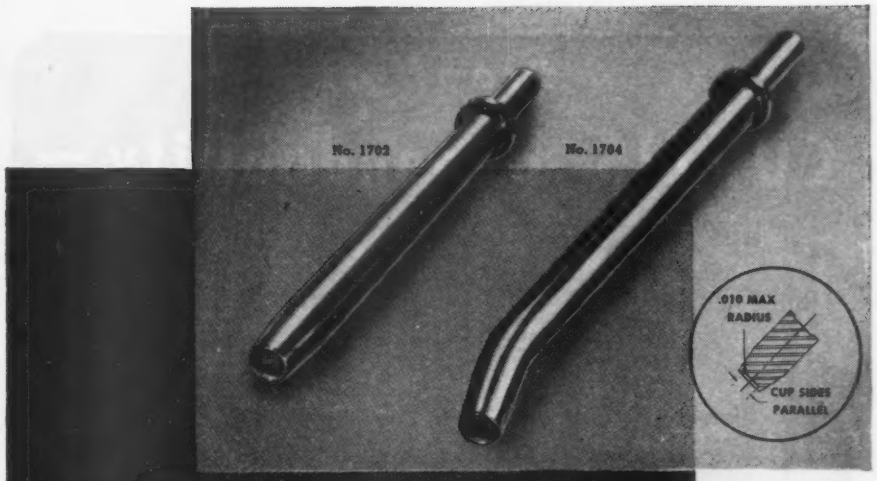
It's small but lusty —concentrated power for dependable performance on many types of jobs requiring maximum power per ounce of weight. 1/20th to 1/200th H.P. From 3000 to 20,000 R.P.M. 6 to 115 volts AC-DC. It's engineered and precision-built to your exact specifications. What type of small fractional H.P. motor do you need? Send specifications and quantity wanted. Write today.

Small Motors, Inc.

1312 ELSTON AVE., CHICAGO 22, ILLINOIS

Manufacturers of special small universal, fractional H.P. motors, dynamotors, shaded pole motors, heater motors, generators.

Design · Engineering · Production



Special

Hard-to-work flat head rivets are easily driven with one hand when the new *engineered* Aero special tool is used. Cups coined to assure uniform dimensional accuracy with a maximum radius of only .010".

Danger of rejects caused by improperly fitting turned tools is eliminated. The new Aero set will not flatten, distort or otherwise weaken flat head rivets, allowing for positive maintenance of rigid engineering standards.

Plants using flush sets to drive AN-442 rivets may substantially increase production and eliminate rejections caused by skin abrasions due to slippage of flush sets. Cost per rivet driven will go down and the strength of the rivet joint will not be impaired when the Aero tool is substituted for incorrect flush sets.

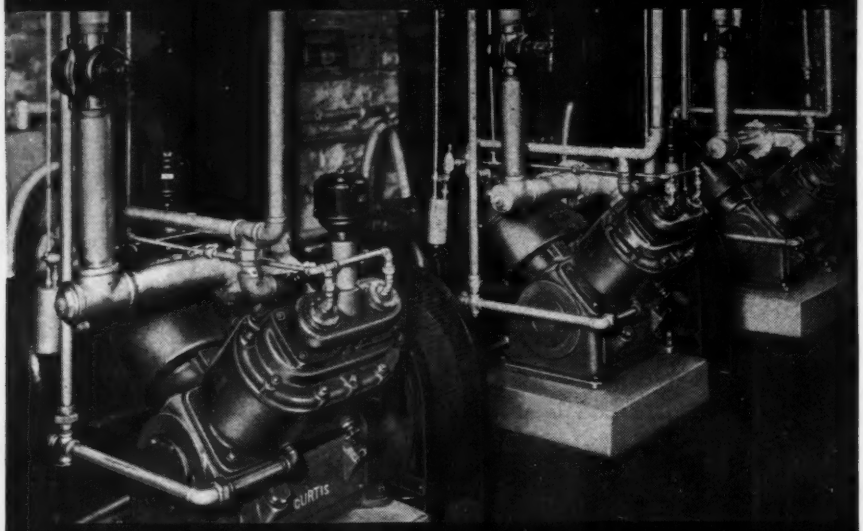
Write now on firm letterhead for full engineering information on the performance of these new rivet sets . . . ask for Catalog Page No. 2B.

Coined AN-442 sets are available in both straight and offset at no increase in catalog prices. Order by number shown above, specifying AN-442 cup in size and length desired.

AERO TOOL CO.

BURBANK • CALIFORNIA

Proof of CURTIS Dependability—



5 Years of 24-Hour Performance At Carter Carburetor Corporation

Installed in 1936 at the St. Louis Plant of Carter Carburetor Corporation, the three Curtis Air Compressors shown above were on almost continuous 24-hour duty for five years. During this period, they operated at 80 lb. pressure, providing air for the entire plant.

J. H. Klasey, plant engineer, states that "they gave surprisingly good service with very little maintenance."

Here is only one example of how Curtis Model "C" Compressors are saving money through dependable performance and freedom from maintenance expense for thousands of manufacturers throughout the country. Curtis economy is the result of such experienced design features as:

- Tapered Roller Bearings
- Carbon-free Disc Valves
- Centro-ring Lubrication
- Automatic Pressure Unloader
- Precision Construction Throughout

Curtis Compressors are available in capacities up to 300 cfm. For proof of their efficiency and operating advantages, send the coupon for full information and free booklet, "How Air Is Being Used in Your Industry."

CURTIS

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CURTIS PNEUMATIC MACHINERY DIVISION
of Curtis Manufacturing Company
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Please send me booklet, "How Air Is Being Used in Your Industry."

Name.....

Firm.....

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CESCO Snap-fas Face Shields

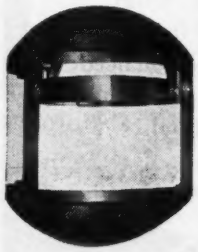
MAKE LIFE SAFER AND EASIE

HERE'S WHY: ★Clear, sturdy plastic visors assure protection. ★New, exclusi CESCO design permits 15-second vis replacement—visors snap off and on wi a turn of the fingers—held fast by sprin clips. ★Extra comfortable—contou shaped, adjustable headgear, soft leath sweatbands.

You'll be glad to know complete detail

STYLE 748—8¼x16-in. visor, fibre half crown

STYLE 438—Hal style face shield, wit placeable extra-l 7x11-in. window



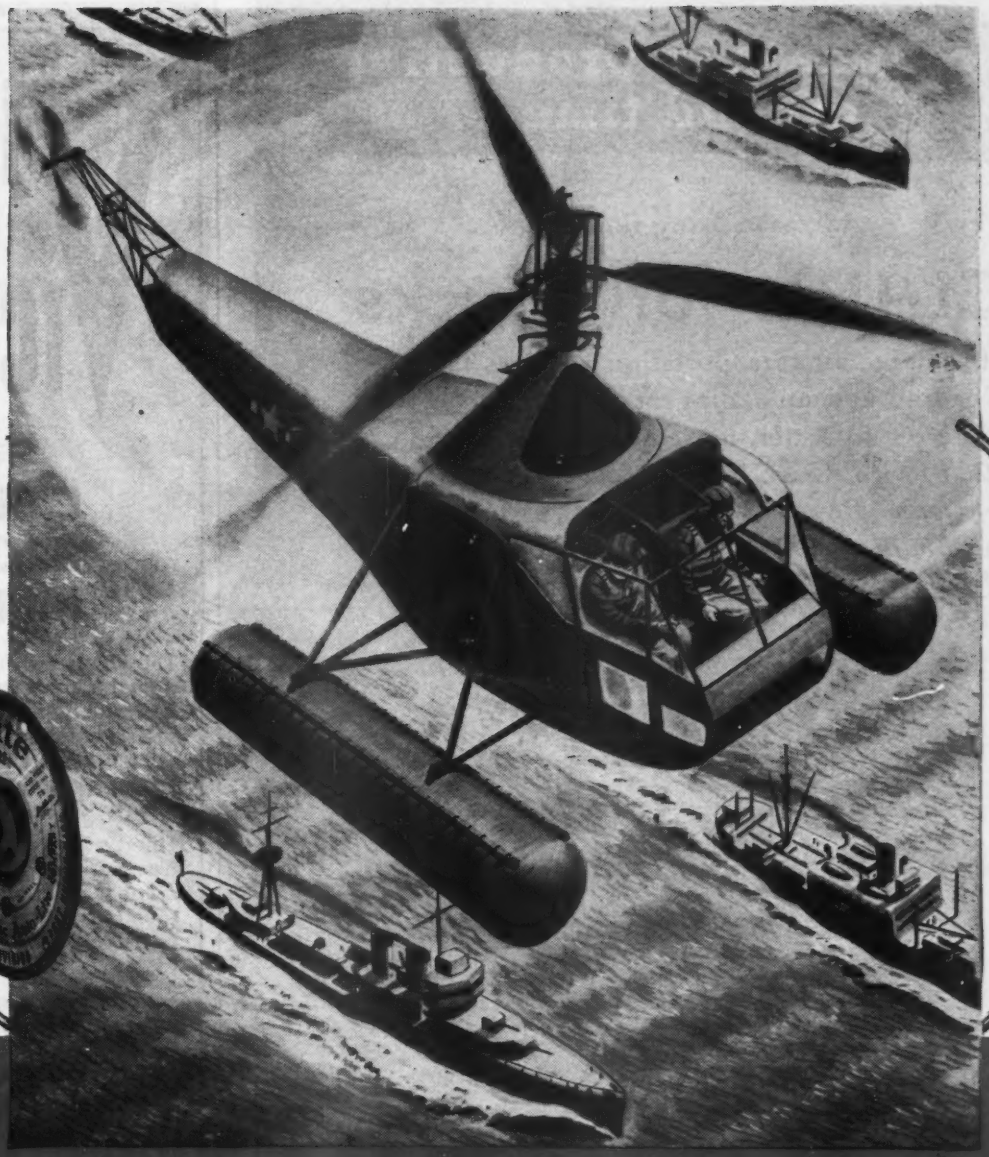
STYLE 439—7x15-in. vis with half crown and bot guard (shown at left)

STYLE 749—equipped wi 10 x 16-in. visor, open headgear (shown at top

Write **CHICAGO EYE SHIELD CO.**
2320 Warren Boulevard
Chicago 12, Illinois

CESCO

CESCO FOR SAFETY



Brother, can you spare a dime... to land on

IT HASN'T the speed, the altitude or the guns that other aircraft have, but the helicopter can do tricks that have proved deadly to the enemy, just the same. No ordinary aircraft can hover directly over enemy subs, pointing them out to the convoy escorting ships for destruction. And no ordinary plane can come straight down to a safe landing on the dime-sized bit of deck space provided on a cargo ship.

To operate successfully under convoy conditions, the helicopter must be built to get there, and back! To help assure the dependability essential to this job, Auto-Lite provides wire of proved performance. An example of such high-quality wire is Steelductor cable, described in Form C-503. Auto-Lite's low-tension, abrasion-resistant wire and cable is covered in Form 838. For copies of these two folders, write to

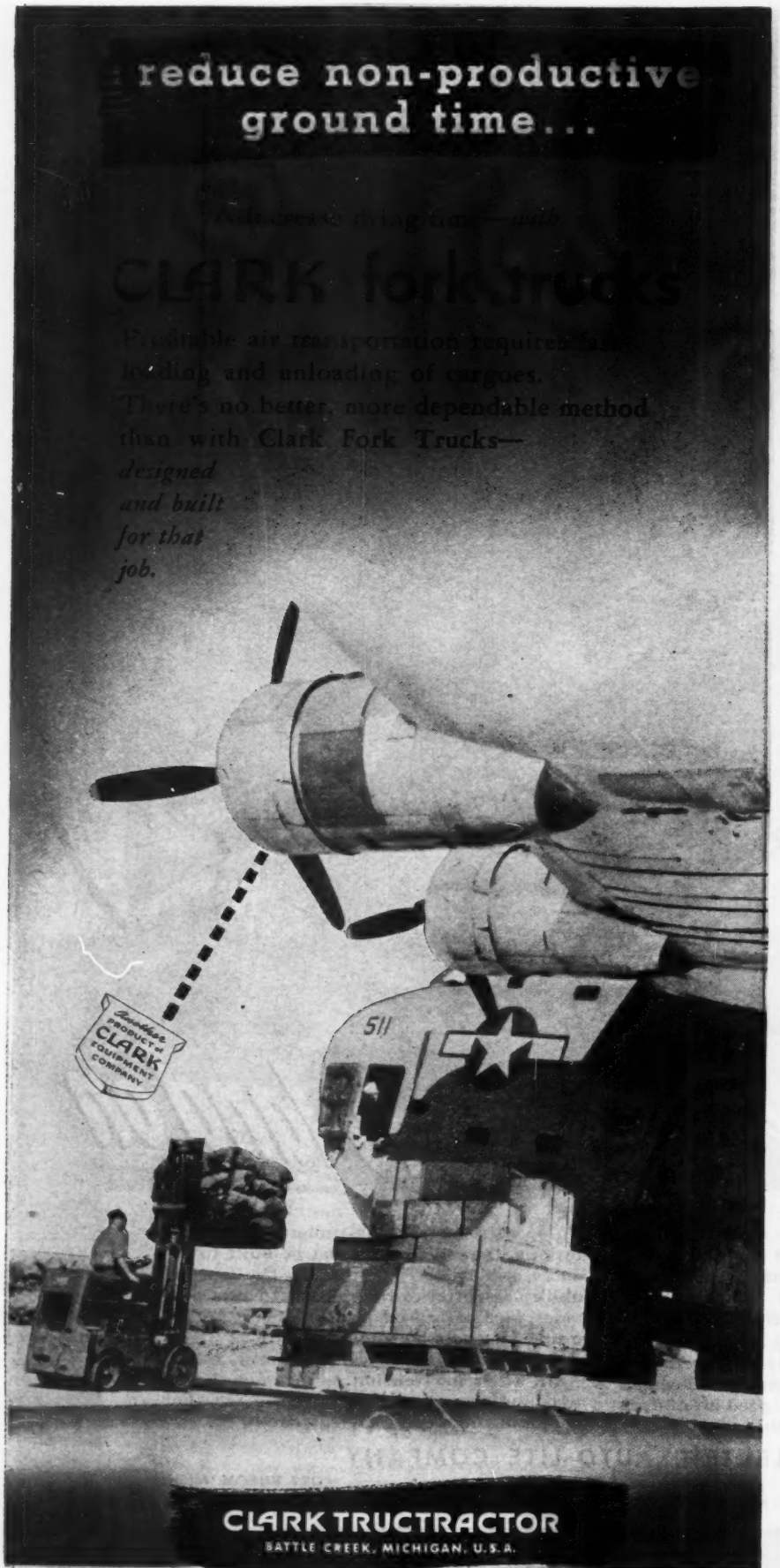
THE ELECTRIC AUTO-LITE COMPANY

SARNIA, ONTARIO — *Wire and Cable Division* — PORT HURON, MICH.

BACK THE ATTACK—BUY AND KEEP MORE WAR BONDS

AUTO-LITE *AIRCRAFT* WIRE and CABLE

TUNE IN "EVERYTHING FOR THE BOYS" STARRING DICK HAYMES—EVERY TUESDAY NIGHT—NBC NETWORK



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AIRCRAFT VISION for VICTORY

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LIBERTY AIRCRAFT MIRROR

The pilots of thousands of Allied fighter planes, now in action over our widely scattered battle fronts, are getting a perfect image of things behind them without eye-strain or fatigue, by means of Liberty Aircraft Mirrors.

Liberty Aircraft Mirrors are all first surface mirrors, and as permanent as their glass base. They give the pilot a clean, well defined image without distortion, immediately.

Each fighter plane equipped with a Liberty Mirror has a mirror built to meet the specific requirements of that plane. Thus the pilot changing from one plane to another gets uniformly good vision at all times, in all planes.

All Liberty Mirrors are now built only for War service, but later these battle tested vision devices will be available to all operators, military, transport or private.

LIBERTY
MIRROR DIVISION
LIBBEY-OWENS-FORD GLASS COMPANY
BRACKENRIDGE
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ARMY (E) NAVY

For sustained outstanding production Liberty has been granted a renewal of the Army-Navy Production Award, entitling them to add a star to their "E" flag.

DEPENDABLE

McDONALD

HOSE NOZZLES

Plate 891—McDonald 1¼" Hose Nozzle (Patented)

Plate 942-S—McDonald SHOCK-PROOF Hose Nozzle 1¼" and 1½" (Patented)

Plate 961—McDonald FUL-FLO Hose Nozzle 1" and 1¼"

McDonald, one of the largest manufacturers in its field, is a thoroughly reliable source for hose nozzles, swing joints, foot valves, emergency and other valves, vents, pump valve manifolds, line strainers, hand rotary pumps and other products designed to add speed and safety to the movement and storage of oil and gasoline.

A. Y. McDONALD MFG. CO.

DUBUQUE, IOWA

Fluid Power Systems

If you have mechanical operations to get done with efficiency and economy, consider Fluid Power.

It is the modern way to transmit power from its source to its job—without shafts, gears, belts or levers.

It moves wherever you want it to go through tubes, and is controlled by valves.

Your Fluid Power system will deliver sure and dependable performance, under all conditions, if it is

Engineered by

PARKER

THE VITAL LINK

in Fluid Power is the Circuit. It goes around corners and into tight places. It must be proof against leak, shock and vibration, and must be pressure-tight.

Parker brings twenty years of experience to the engineering of this Vital Link. We build the valves and fittings, and the tools to handle them.

This specialized "know-how" is yours to command.

* * *

You'll find it worth-while to talk with a Parker Fluid Power Engineer. Write to The Parker Appliance Company, 17325 Euclid Ave., Cleveland 12, O.

PARKER

THIS DUGAS SCREEN

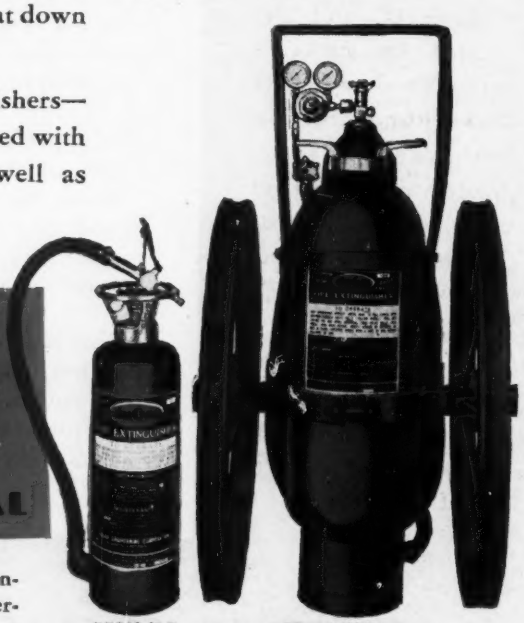
SHIELDS FIRE-FIGHTERS

● Dense clouds of fire-killing dry chemical create a real "heat-shielding screen" for the operator whenever a DUGAS Fire Extinguisher, charged with PLUS-FIFTY DUGAS Dry Chemical, is used to beat down a blaze.

All DUGAS Fire Extinguishers—large and small—are designed with fire-fighter protection as well as fire-fighting effectiveness in mind—a big reason why workers who may have to be fire-fighters feel more confident when they see DUGAS equipment close at hand.

PLUS-FIFTY
AN ANSUL PRODUCT
duGas
THE MASTER OF FLAME
DRY CHEMICAL

Non-toxic, non-corrosive and non-abrasive. Approved by Underwriters' Laboratories and Factory Mutual Laboratories.



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DUGAS 150 WHEELED EXTINGUISHER

ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN
DUGAS DIVISION

3½ ounces

WITH TWELVE CONTACTS

GENERAL CONTROL COMPANY'S NEW MODEL MCM "MIDGET"

LEVER SWITCH

The "Midget" is designed especially for electronic and communications circuits in aircraft, and for other light duty applications. It is a "Midget" in both size and weight . . . it saves precious space and weight, yet is so ruggedly constructed that it will stand severe use.

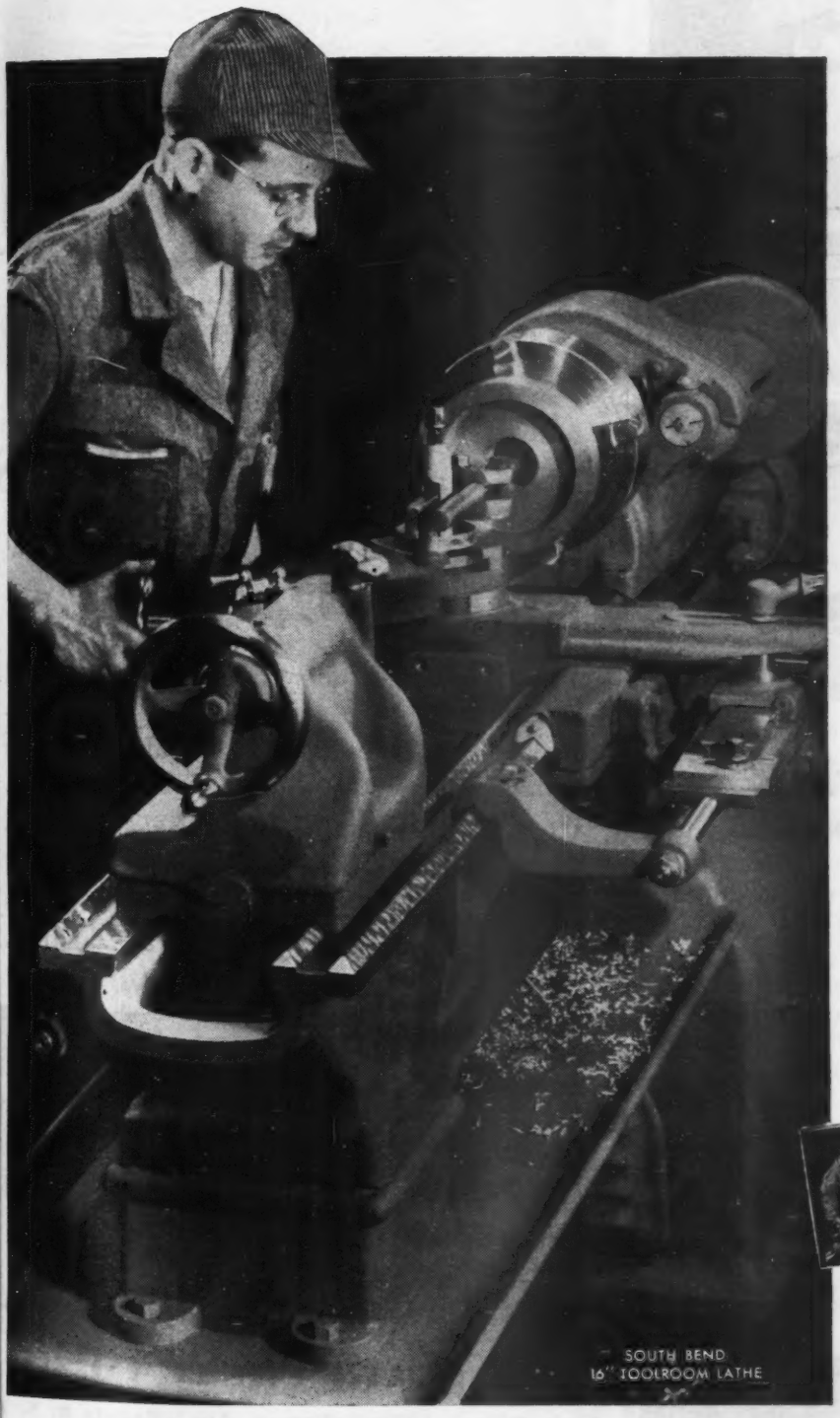
The contact possibilities are unlimited . . . contact assemblies can be removed from the frame by removing a single bolt . . . all parts are non-corrosive . . . has easy, positive roller action, regardless of number or arrangement of contacts on each side of the switch . . . a single hole only is required for panel mounting . . . a key can be provided to prevent turning in the mounting panel . . . rated from 5 to 10 amperes, 125 volts A.C.

The standard "Midget" has either three positions as shown in illustration, or can be supplied with two positions (no neutral).

GENERAL CONTROL COMPANY
1207 SOLDIERS FIELD ROAD
BOSTON 34, MASS.

PRECISION

— AS VITAL IN WAR AS IN PEACE



In every theater of war South Bend Lathes are holding to their pre-war traditions for dependable precision. In the mobile machine shops of our mechanized forces they duplicate factory tolerances on intricate parts needed for emergency repairs on guns, tanks, trucks and other essential equipment. On board many of the Navy's fighting ships, where high precision is an absolute requirement, they are also depended upon for maintenance and repair of mechanical equipment. In the repair bases of the Air Forces they play an equally important part in keeping planes in service. Sometimes small South Bend Lathes are even flown to remote locations for making quick repairs on grounded planes.

In all classes of war service these lathes are doing fine precision work—not only with the armed forces but also in industry where dependable accuracy is as vital as speed and versatility in meeting war's urgent production schedules.

When civilian production is resumed South Bend precision will again prove as indispensable to peace-time industry as it is now for exacting war work. Embodying the improvements developed to meet war production requirements, South Bend Engine Lathes and Toolroom Lathes will be available, also the South Bend Precision Turret Lathes having ½" and 1" collet capacity.

NEW CATALOG NOW READY

Write For It!

Illustrated in full color—this new 64-page catalog shows all types of South Bend Lathes, Engine Lathes and Toolroom Lathes with 9", 10", 13", 14½", and 16" swing. Precision Turret Lathes with ½" and 1" collet capacity. Shows complete line of accessories and attachments for use with these lathes. *Ask for Catalog No. 100-D.*

Lathe Builders for 38 Years

SOUTH BEND LATHE WORKS

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Super Powered!

U S *Super-Positive* Piston Rings

designed and machined to consistent perfection, serve wherever air might is needed to turn the tide of battle. Bombs and war freight of unbelievable tonnage are carried by giant planes that literally encircle the world.

Based on a traditional policy of research and unyielding adherence to the most exacting manufacturing controls, U. S. *Super-Positives* will, when peace comes, continue to be the accepted standard of Aviation quality.

YOUR BONDS WILL SHORTEN THE WAR—BUY MORE

For Ring Conditions Favoring Peak Performance...

Use U. S. Super-Positives

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STIRLING, NEW JERSEY, U. S. A.

IRVIN *Air Chute*

"SINGLE-RELEASE" Harness

UNITED NATIONS' FLYERS *are using it for* SAFER LANDINGS

A one-hand turn and a tap on the single frontal disk instantly releases the harness . . . leaving the flyer entirely free. Accidental release is impossible before disk is "set" for action.

All United Nations' Air Forces for years have used IRVIN as standard equipment . . . and now the Irvin "Single-Release" harness is acknowledged as superior for all landings. IRVIN, as always, leads in Safety.

Twist & Set *Tap for Release* *Harness Falls Off*

IRVING AIR CHUTE CO., Inc.

Main Office: 1670 Jefferson Ave., Buffalo 8, N. Y.

Complete Factories in Buffalo, N. Y., Glendale, Calif. (1... Flower St.), and Lexington, Ky., U. S. A.—Canada, England ... Sweden . . . All Serving the United Nations' Air Forces.

B U Y M O R E B O N D

LET SIMMONDS ANALYZE YOUR CONTROL PROBLEM

Simply submit the basic requirements, as follows:

- What does the control operate?
- LOAD: Compression (lbs.) Tension (lbs.)
- VIBRATION CHARACTERISTICS
- TEMPERATURE CONDITIONS
- PRESENT SYSTEM
- FLEXIBLE OR RIGID HOUSING?

Make sketches of top and side views of installation. Use regular graph paper and indicate unit of measure.

TOP VIEW

SIDE VIEW

SIMMONDS EQUIPMENT FLIES WITH EVERY TYPE OF ALLIED AIRCRAFT

Automatic Engine Controls — Push-Pull Controls
Spark Plugs — Hydraulic Accumulators
Hydraulic Fuses — Chronometric Radiosondes
Fasteners and Clips of Specialized Design

TOUGH but typical of the remote control problems successfully solved by the Simmonds precision-built Push-Pull Controls is the one described above. Designed to meet the exacting conditions of aircraft operations, more than half a million Simmonds Controls are today flying on every Allied battlefront. Increasingly, Simmonds Controls are also being specified for installation on tanks, ordnance, automotive and industrial units to replace cumbersome rod and bellcrank or pulley and cable systems, and even pneumatic lines.

Basically, the Simmonds precision-built control consists of a series of "metal beads" strung on a cable and enclosed in either a rigid or a flexible tubing. The "beads" give the push and the cable the pull — hence the push-pull of two-way control. Straightline travel can be transformed into rotary motion by means of the Radian Unit; a variety of other fittings and accessories are available.

Under difficult conditions involving bends and detours around fixed installations, or involving vibration or relative motion between two units, and wherever the ultimate in precision remote mechanical control is required, Simmonds Controls are proving their outstanding merit.

Let Simmonds engineers help solve your remote control problems. For a free and constructive analysis, send data concerning your requirements, as suggested in the panel at left, to the nearest Simmonds office.

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Simmonds PRODUCTS INC.

BRANCH OFFICES: DAYTON • WASHINGTON • GLENDALE, CAL. • MONTREAL
MANUFACTURING PLANTS: NEW YORK • VERMONT • CALIFORNIA

"Look, son . . . now they're flying 'em at night!"

TANKS are loaded. Mail's stowed. Contact! A frail plane rises into the night—Cheyenne bound out of Chicago. The world's first serious attempt at night flying on a set schedule makes July 1, 1924, a date to be remembered forever in aviation history.

Lights—on the ground, on the planes themselves—made it possible for the first air mail night pilots to reach their destinations. And riding with those early planes, guaranteeing the immediate and uninterrupted response of each vital light, were generators and voltage regulators bearing the name Leece-Neville.

* * *

This month, The Leece-Neville Company observes its 35th anniversary, steeped in the business of providing vital electrical equipment for the implements of war. Generators, regulators, switch relays and pump motors for aircraft . . . cranking motors, generators, regulators and switches for marine and land type Diesel engines . . . cranking motors, generators and regulators for trucks and buses. Everywhere, however used, these products are living up to the high quality standards that were set by B. M. Leece and S. M. Neville when they organized their company back in 1910.

Concentrating always on making its equipment better, Leece-Neville has introduced a continuous stream of new products and product improvements, many of which have set the pace for their entire industry.

And now, looking ahead from today's milestone, Leece-Neville promises its old customers and its prospective customers that it will continue this program of pioneering new developments . . . that it will continue to build the utmost quality into everything it makes.

35th Anniversary

The **LEECE-NEVILLE** *Co.*

CLEVELAND, OHIO

Pioneer and still Quality Leader in heavy duty electrical equipment

FOR AIRCRAFT SPECIFY LEECE-NEVILLE GENERATORS, VOLTAGE REGULATORS, SWITCH RELAYS, PUMP MOTORS

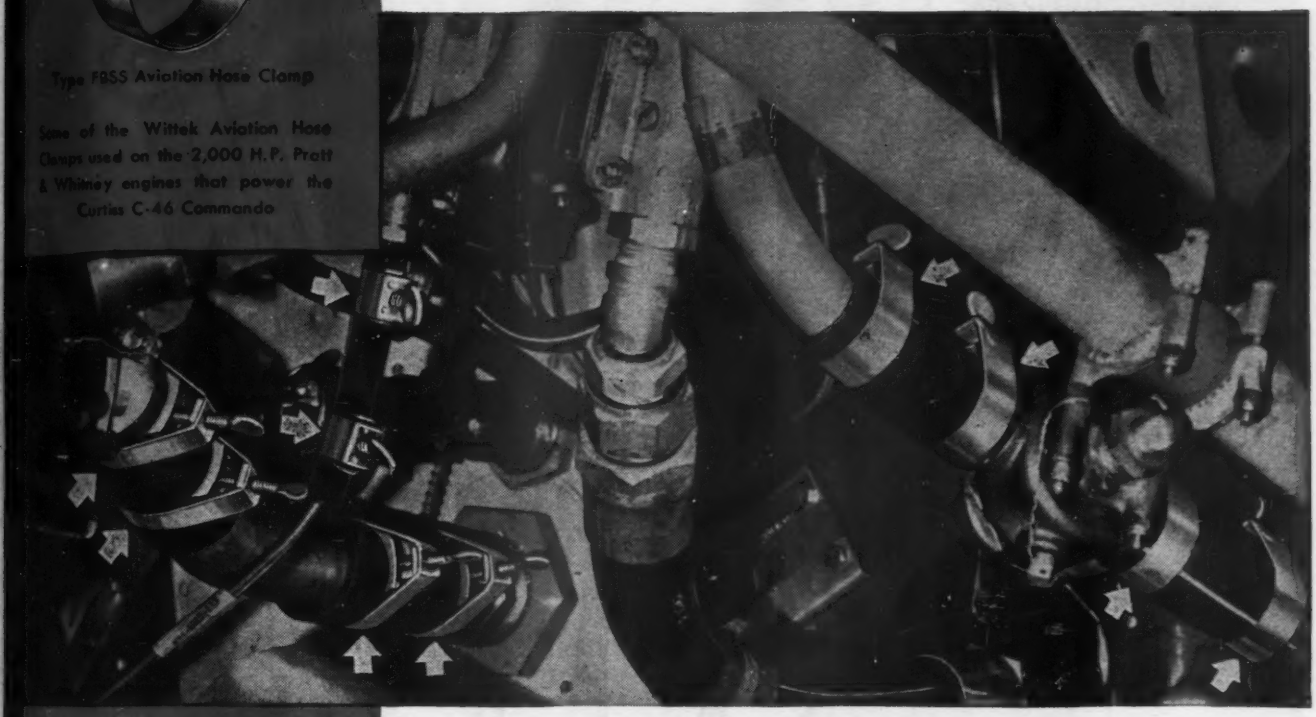
Standard in the Aviation Industry

WITTEK

Aviation Hose Clamps

Type FBSS Aviation Hose Clamp

Some of the Wittek Aviation Hose Clamps used on the 2,000 H.P. Pratt & Whitney engines that power the Curtiss C-46 Commando



Type WWD Worm Drive Aviation Hose Clamp

Wittek now offers two distinctly different aviation hose clamps complying with the requirements of specification AN-FF-C-406A.

Type FBSS—is manufactured in the standard AN-748 sizes and incorporate a bridge extender which provides uniform sealing characteristics. This is the most effective type hose clamp for all applications in which an adjustable clamp is not necessary.

Type WWD—a worm drive stainless steel hose clamp which, because of its wide range of adjustment, is the most effective clamp for uses where a clamp capable of accommodating various diameters of hose is necessary.

These two Wittek Aviation Hose Clamps are made from stainless steel, and combine the superior physical qualities of that material with the well-known Wittek qualities of superior service and high dependability. There is a Wittek Hose Clamp to meet every requirement of the Aviation Industry. Write for new descriptive catalog.

War Bonds for Victory

ARMY E NAVY

WITTEK
MANUFACTURING CO.
4305-15 West 24th Place, Chicago 23, Ill.

Aviation HOSE CLAMPS

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SCREWDRIVERS ARE *HUSKIER!*

"FROM **MIDGETS** • • •

• • • TO **GIANTS**

Compare Plomb screwdrivers with others and you'll agree they're unequalled for maximum strength yet minimum weight. Plomb makes them in all styles and sizes, as illustrated—wood handled, plastic handled, square and round bladed, large and small.

If you want to feel proud of the tools you use, plan now on building up an assortment of these husky screwdrivers, and the other fine tools in the complete Plomb Line. Every one will give you exclusive quality features — advantages that make them the choice of experts for better, safer, longer-lasting service. Buy them on display from your Plomb Distributor, or write for name and address of the one nearest you. Free catalog on request. — Plomb Tool Company, 2221 Santa Fe Avenue, Los Angeles 54, California.

Plomb screwdrivers are made in bit widths from 1/8" to 9/16", and blade lengths from 1" to 14".

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FINE HAND TOOLS

Proved in War use —

There's a

GULF QUALITY RUST PREVENTIVE

for each specific need!

Available now for protecting your surplus equipment

Every type specially suited to provide maximum protection

When you change over from swords to plow shares, make sure your surplus tools and equipment are properly protected against damaging rust.

From Gulf's complete line, you can select one or more war-proven rust preventives that will meet your every requirement for both interior and exterior use—and provide positive protection for indefinite periods.

Gulf quality rust preventives have given an excellent account of themselves in protecting all types of metal parts and war equipment during storage and transportation overseas. They meet Government specifications for exterior and interior application, and are available now for immediate delivery.

For further information on Gulf quality rust preventives, write, wire, or phone your nearest Gulf office.

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A New Electronic FLUXMETER

By HICKOK

For Comparing Flux Density in Magnetic Fields

● Here is a modern and versatile electronic instrument for the comparison of flux density, in all types or shapes of permanent or electro magnets. The flux density is read on the indicating meter while the coil remains at a fixed point in the field. The device is static. The field strength is amplified so that a rugged meter may be used to insure dependability and accuracy. It is fast and very simple to operate.

Weak magnets can be quickly and accurately classified. Aging by vibration, counter-magnetic fields, temperature, variations in grain structure and hardness, etc., are readily shown on the Hickok Fluxmeter.

By a suitable stationary exploring inductor, the Fluxmeter provides a rapid means of measurement on any assembled product. The field of a loud-speaker, the flux density in the air gap of assembled meters; and either disc or bar type magnets can be readily ascertained. Used to measure both A.C. and D.C. fields. Write for literature.

THE HICKOK ELECTRICAL INSTRUMENT CO.
10525 Dupont Avenue, Cleveland 8, Ohio

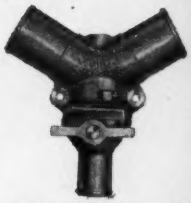
PRECISION CALIBRATED • LASTING ACCURACY

KOEHLER

AIRCRAFT OIL DRAINCOCKS —VALVES and SOLENOIDS

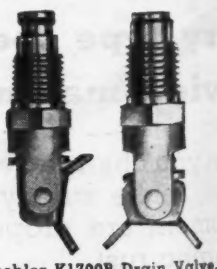
(For Fuel — Oil — Coolants)

Specified as standard equipment on America's most renowned fighters and bombers . . . the highest tribute that could be paid to the outstanding superiority of Koehler Aircraft valves and solenoids. The culmination of 13 years experience in building similar products, Koehler oil valves are proving their worth where results count most.



Koehler's Oil Draincocks—operate freely in all temperatures.

K-1610B OIL DRAIN VALVE Poppet Principle Weighs Only 6 Oz.



Koehler K1700B Drain Valve. A fool-proof drain valve developed to save service hours. Available in all sizes.

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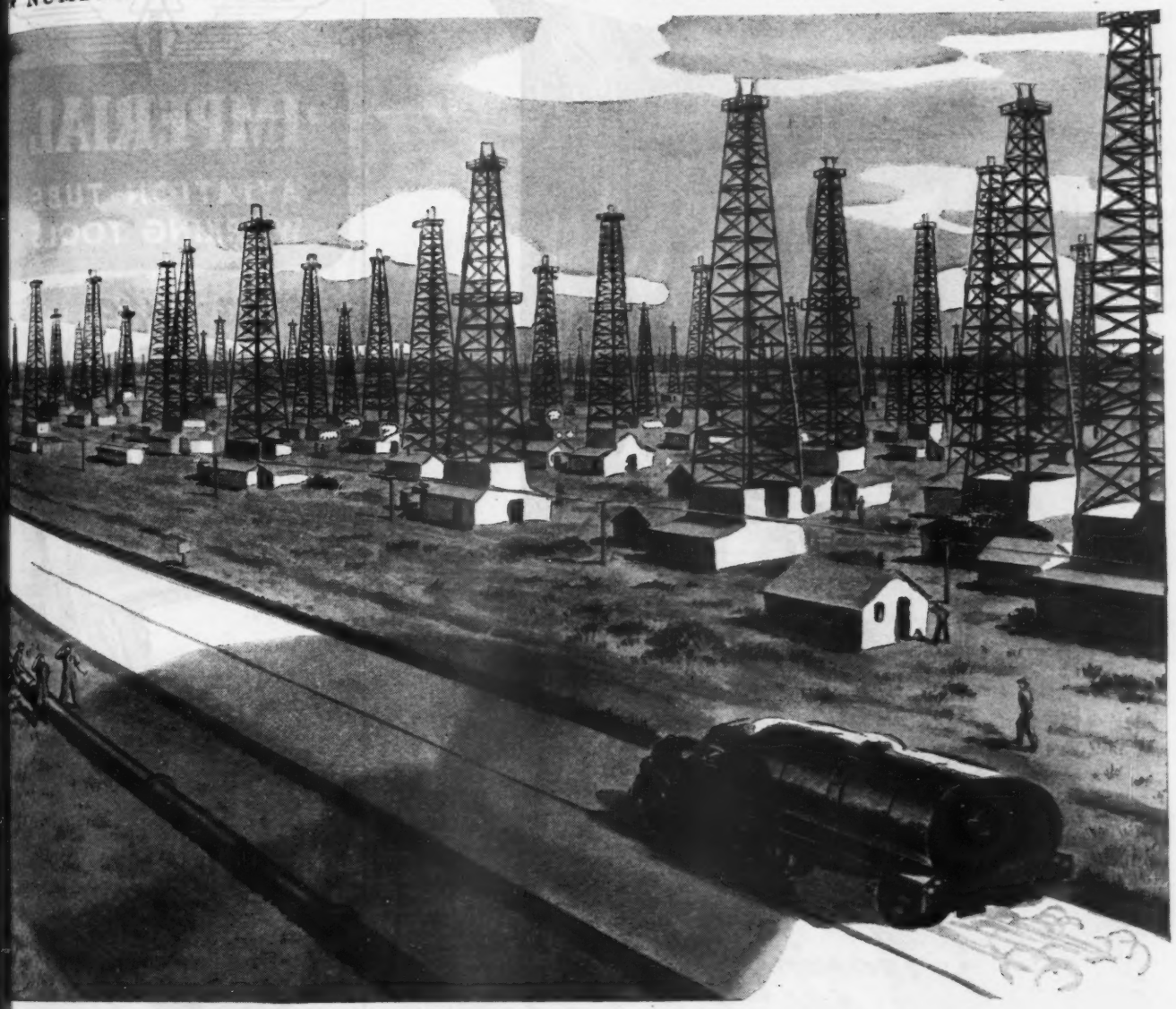
Producers of Aircraft (Oil and Fuel) Valves since 1931

★ NUMBER 13 IN A SERIES OF MESSAGES BY KELLETT AIRCRAFT CORPORATION ★



"COMING EVENTS CAST THEIR SHADOWS . . ."

Over busy cities . . . industrial scenes . . . rolling farm country . . . wild, wooded regions, the shadows of rotary wings will be familiar sights . . . as helicopters take their place in future air transportation. Today, details of helicopter advances in design and in performance are not available to the public . . . but the progress made during the war, under Government sponsorship, promises a practical, useful type of aircraft with special flying abilities, freeing it from airport limitations. Kellett's experienced engineers and production organization look forward confidently to the time when the helicopter will serve alongside conventional aircraft, in the air-minded world of tomorrow.

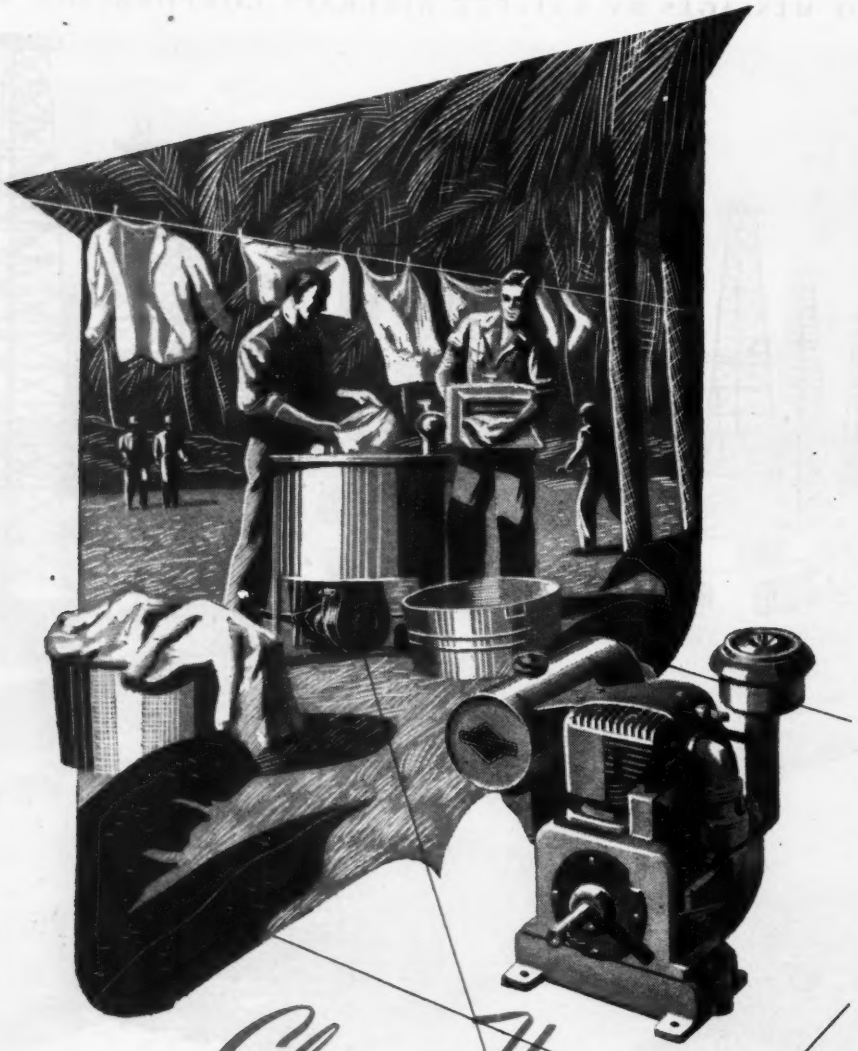
. . .

SEND FOR INTERESTING BOOKLET

Are there questions in your mind about what the helicopter can do, its capacity, cost or speed? Send for "Answering Some Helicopter Questions." Kellett Aircraft Corporation, Dept. I, Upper Darby (Philadelphia) Pa.

KELLETT

LDEST ROTARY WING AIRCRAFT MANUFACTURING COMPANY



Cleaning Up on All Fronts!

Our fighting men are doing a double "clean-up job" on all fronts. To combat dirt and disease they use modern washing machines powered by trouble-free, air-cooled Briggs & Stratton gasoline engines — one more service for hundreds of thousands of Briggs & Stratton engines, now "humming" away for Victory.

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4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

Manufacturers, distributors, dealers, and users of all types of appliances, tools, and equipment requiring dependable, compact power units vouch for the performance record of Briggs & Stratton engines. The latest models are backed by the experience gained in twenty-five years of *continuous* production of more than 2,000,000 *Air-Cooled* Gasoline Engines. BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U.S.A.

IMPERIAL

AVIATION TUBE WORKING TOOLS

Roller-type

TUBE CUTTER

Illustration sho
No. 212-F Avi
tion Tube Cut
being used to r
move a flare fro
a piece of tubi

This tool was developed specifically for aircraft work and is scientifically designed to make the clean, right angle cuts essential to perfect AN type flares. Cuts aluminum, aluminum alloy, copper, brass or steel aircraft tubing in sizes from ⅛" to 1⅛" O.D.

Tubing rests against rollers making operation easy and preventing galling or rubbing. Special flare cut-off groove removes damaged flares with a minimum of waste; often eliminates replacing the tubing entirely.

Tool handles a greater range of tubing sizes than ordinary cutters. Strongly constructed for long service. Handy reamer for removing burrs from tubing is a part of the tool.

Write for Bulletin No. 800

AVIATION DIVISION

THE IMPERIAL BRASS MANUFACTURING CO.

1204 W. Harrison St., Chicago 7, Illinois

WESTON

Aircraft Instruments

Cylinder Temperature Indicators (Single & Dual)
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Carburetor Air Temperature Indicators
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Flap Position Indicators
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Frequency Meters
Ammeters—Voltmeters—Voltammeters
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Radio Panel Instruments
Radio Testing Equipment
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MODEL 827
Dual Cylinder Temperature Indicator

...ratory Standards . . . Precision DC and ...ortables . . . Instrument Transfomers ... Sensitive Relays . . . DC, AC, and ...me Switchboard and Panel Instruments.

WESTON

Specialized Test Equipment . . . Light Measurement and Control Devices . . . Exposure Meters . . . Aircraft Instruments . . . Electric Tachometers . . . Dial Thermometers

...ESTON ELECTRICAL INSTRUMENT CORP., 685 Frelinghuysen Avenue, Newark, N. J.

FOR FINER
FASTER FINISHING
Use DREMEL MOTO-TOOLS
Model 2 Moto-Tool, complete with accessories, as illustrated, in felt-lined hardwood case—$23.50. Model 2 Moto-Tool only, with emery wheel point — $16.50.
27,000
R.P.M.

Long before Pearl Harbor, Dremel MOTO-TOOL won its spurs by the way it tackled tough jobs in tool rooms and machine shops, and on production lines. But since American industry swung its full strength into war production and our armed forces established far flung assembly and repair bases the already healthy demand for these mighty little midgets has quadrupled.

Operators as well as owners of Moto-Tools are constantly discovering new jobs . . . new ways to save time and cut costs . . . with these pocket size machine shops. Girls quickly become proficient in the use of them because a Moto-Tool weighs but 13 ounces, is shaped to fit the hand, has a balanced armature to prevent vibration. Thousands of Moto-Tools are helping to establish production records in plants such as General Electric, Westinghouse, Remington Arms, Ford, Nash-Kelvinator, Consolidated Aircraft, Northrup, Douglas, and many others. Besides, Moto-Tool has won the respect of every branch of the U. S. land, sea and air forces.

A Model 2 Moto-Tool develops 27,000 rpm . . . the proper speed for clean, smooth, accurate work, and long life from points and cutters. It is sturdily built throughout and has a shock-proof bakelite housing and oilless (oil sealed) bearings. Uses 110-120 volt AC or DC current. Ask your Mill Supply salesman or write the factory or representatives below about Dremel Moto-Tools and accessories.

Prompt Shipment on Orders with Proper Priority.

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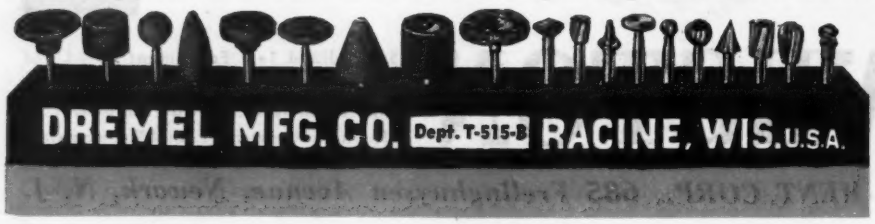
Whether you have a Moto-Tool or any other type of grinder, use only genuine Dremel shop-tested Accessories—steel cutters, emery wheel points, brushes, sanders



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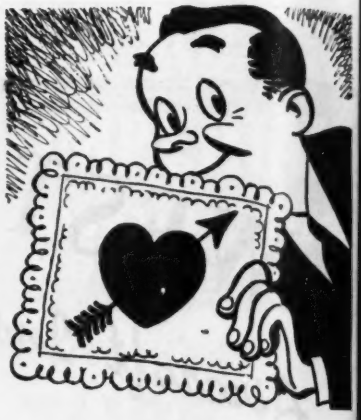

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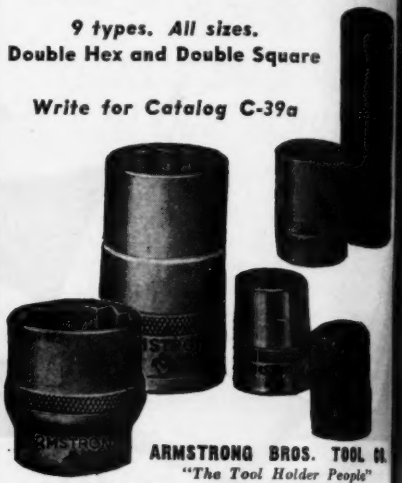

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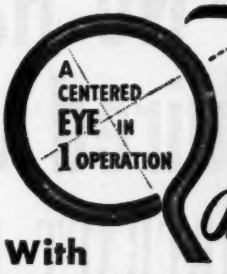

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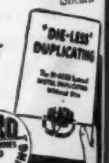

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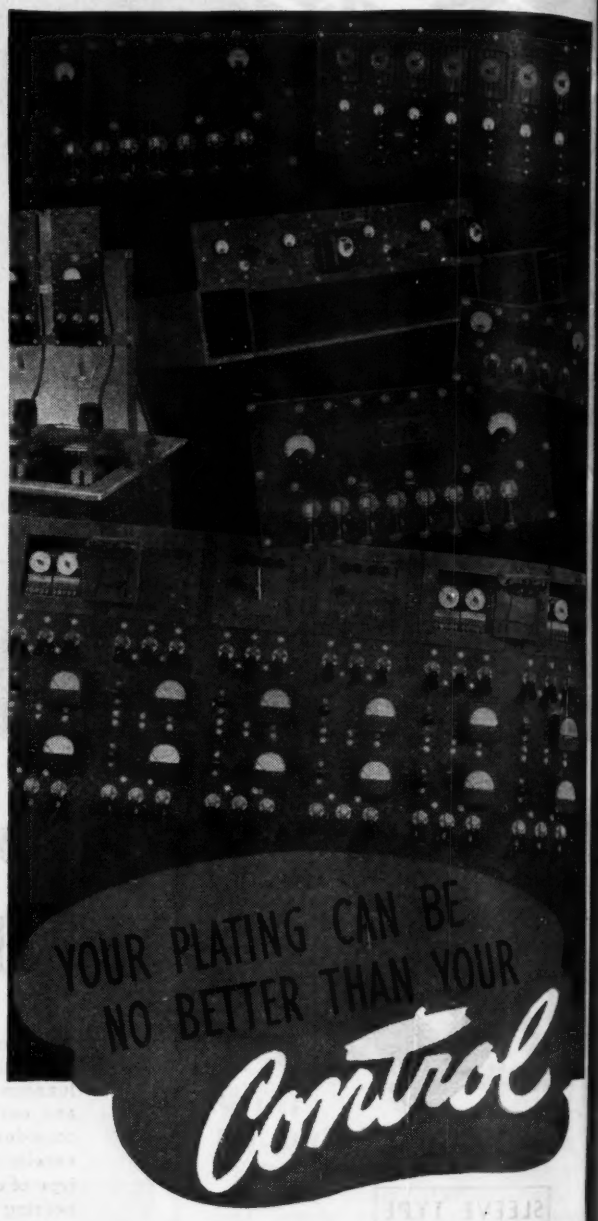

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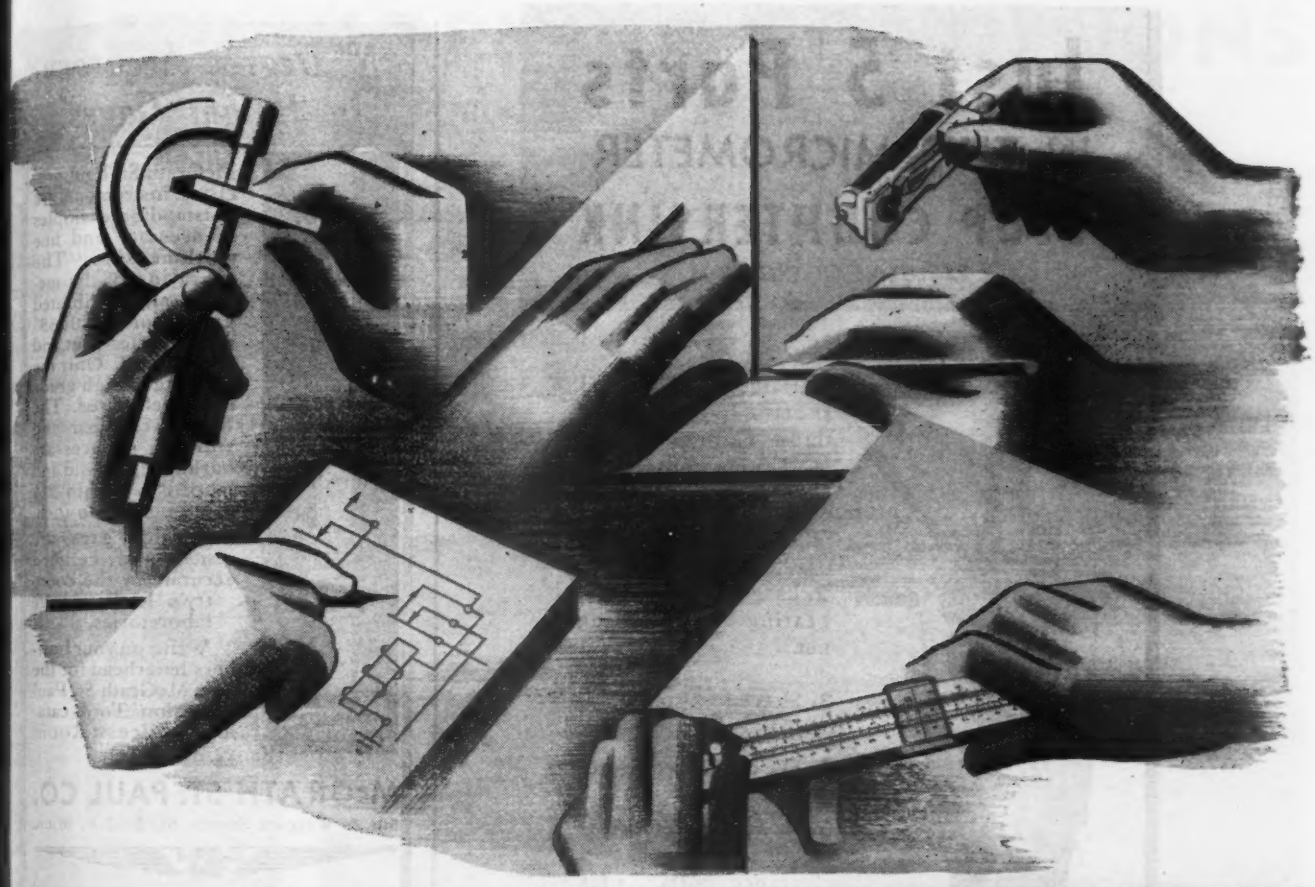
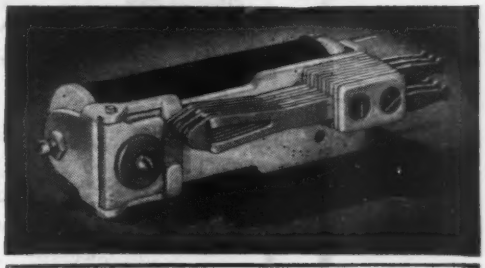


Your New Product may need the Magic of Electrical Control



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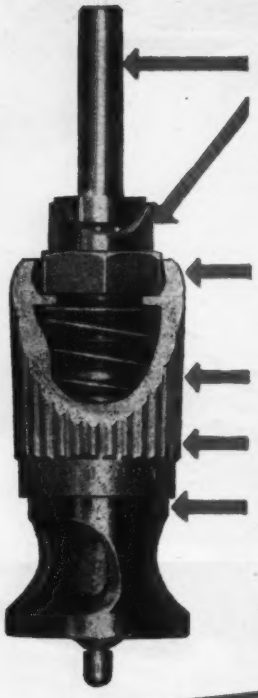

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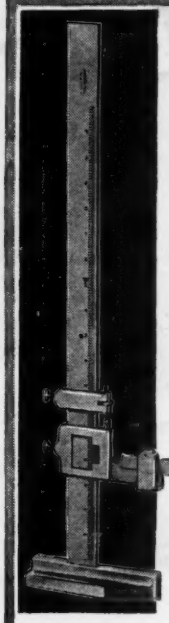

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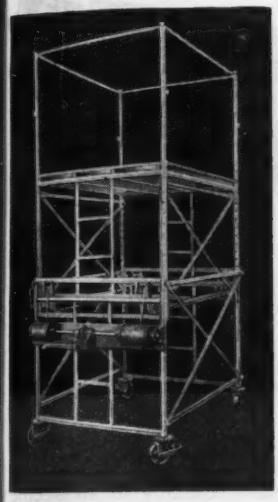
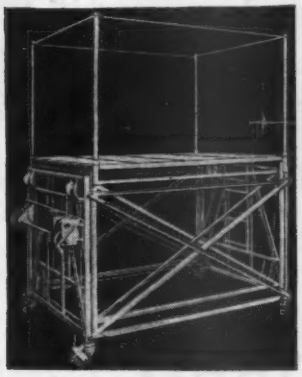


GOLD MEDAL TELESCOPING WORKSTANDS



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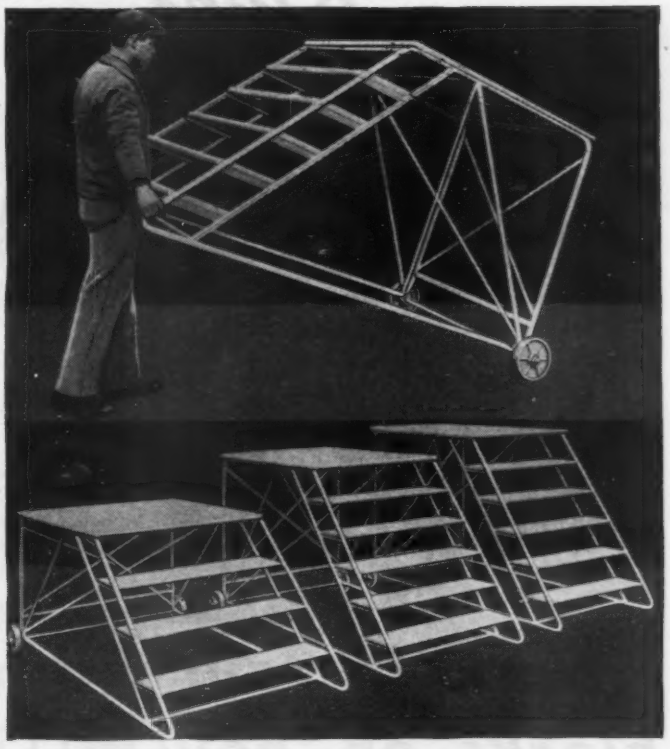

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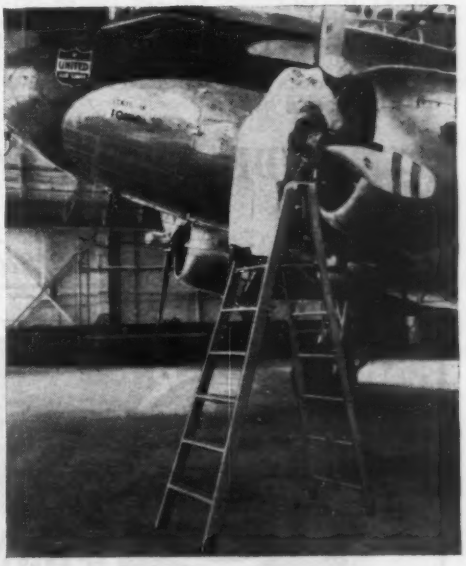

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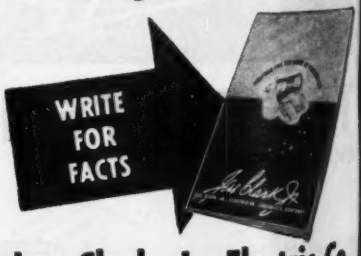

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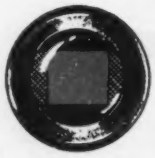

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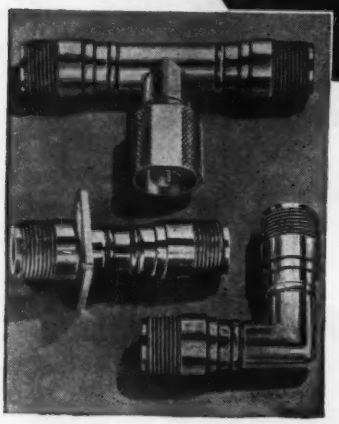

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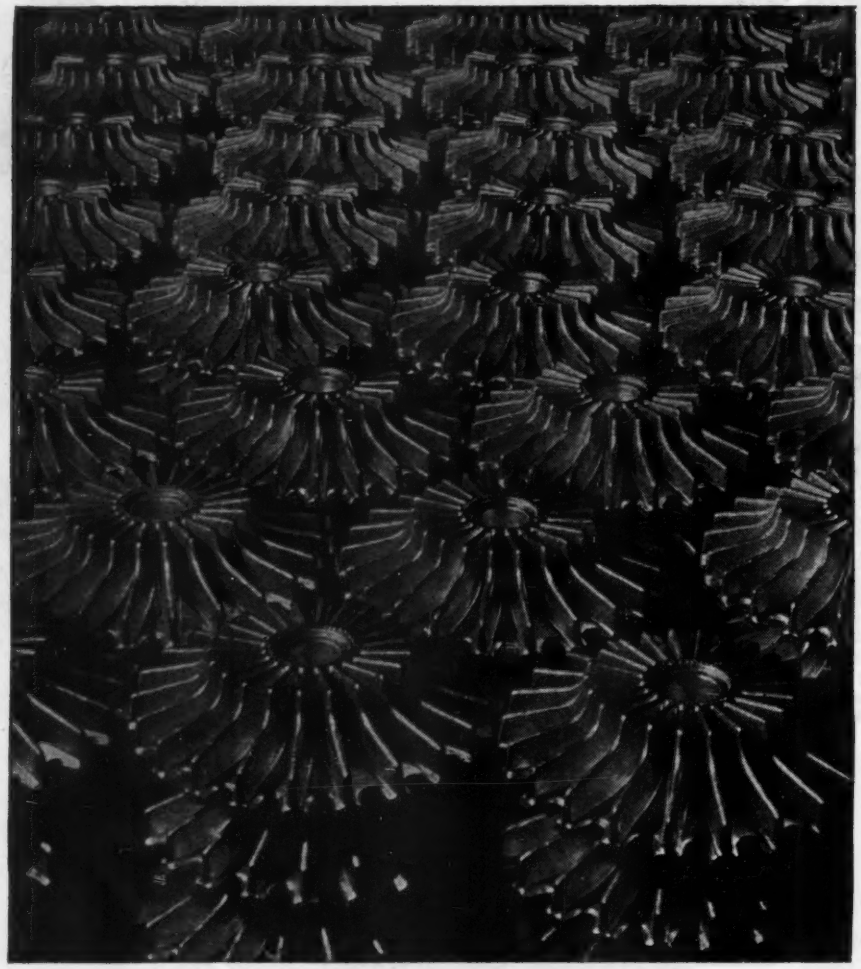

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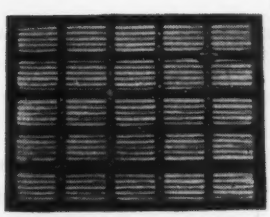

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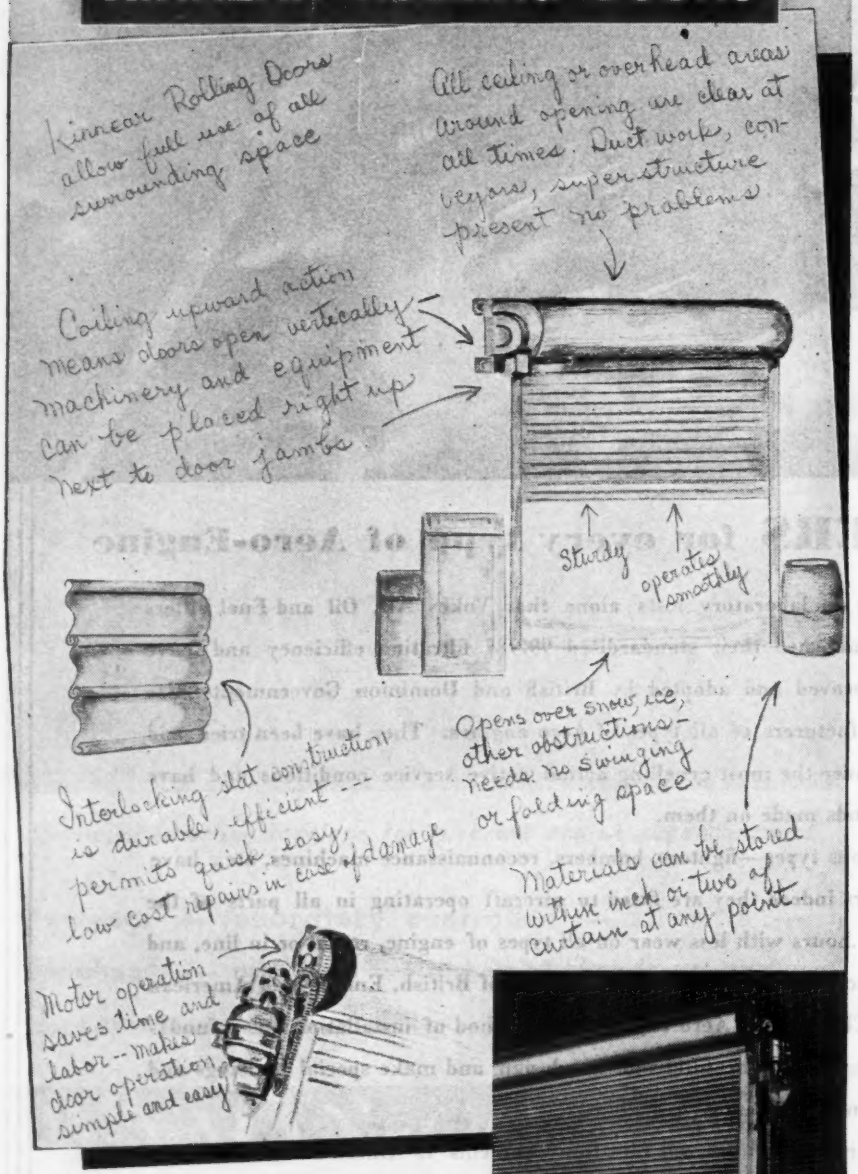
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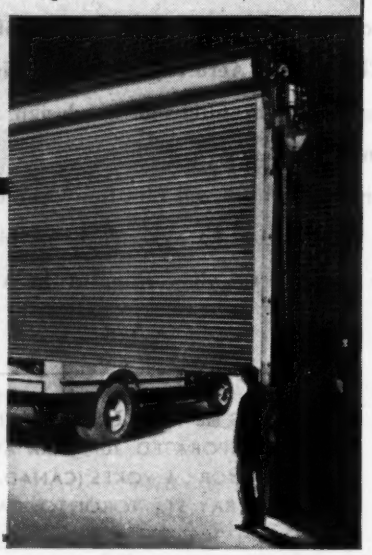

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(*Continued from page* 112)

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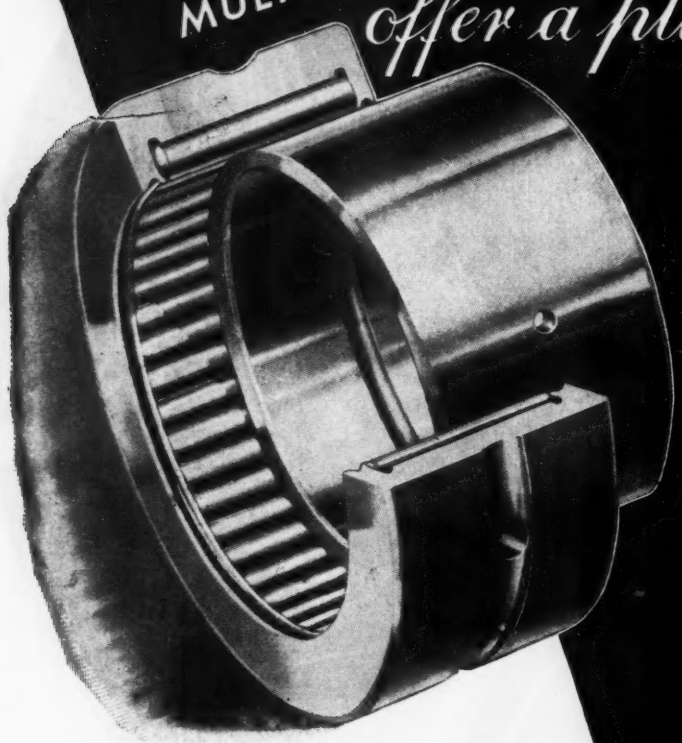

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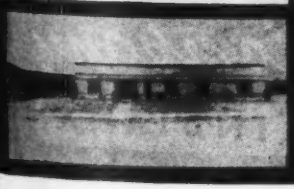

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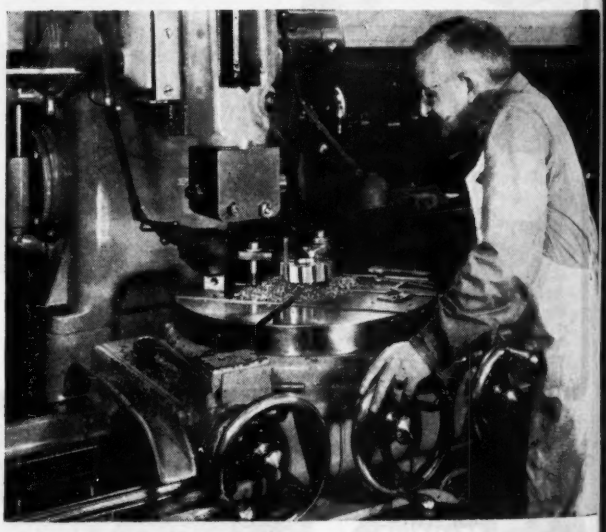

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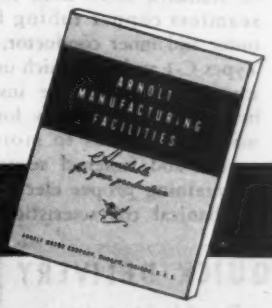

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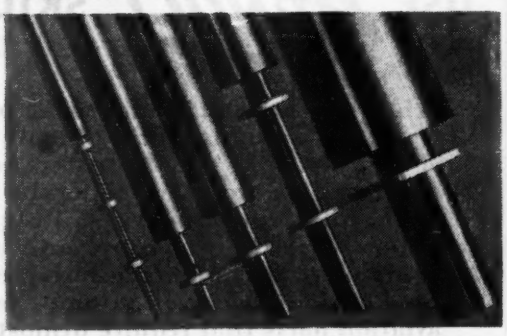

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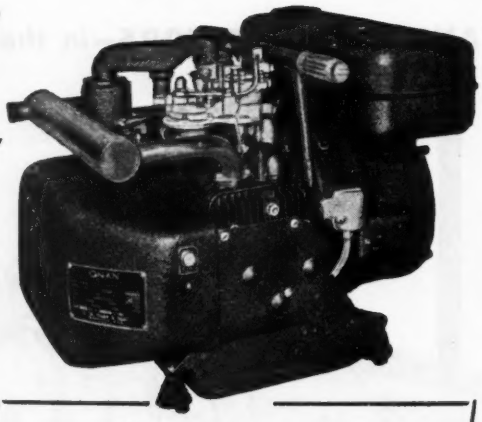

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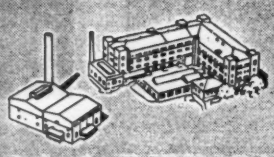
ESTABLISHED  1866

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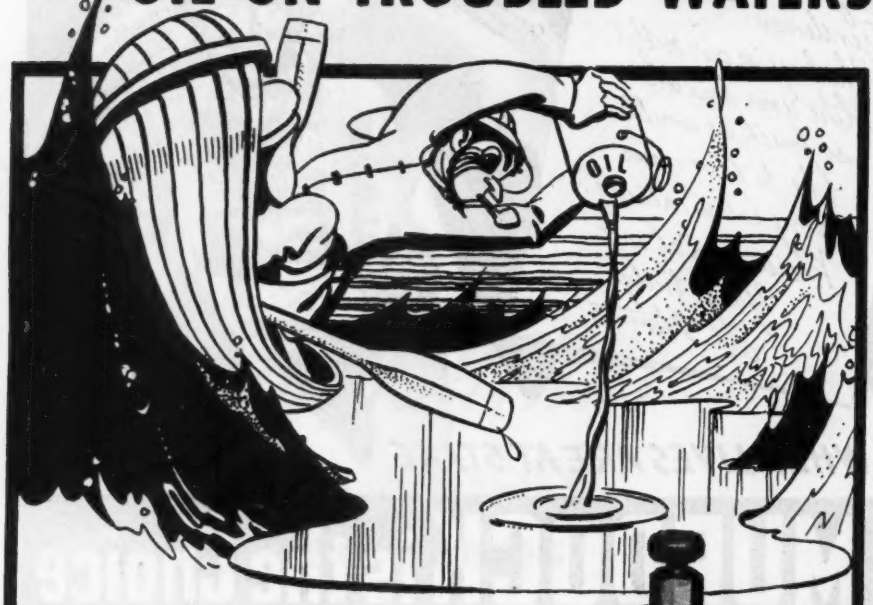

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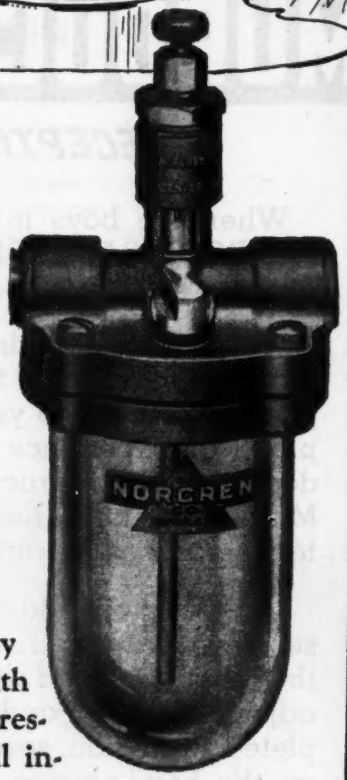

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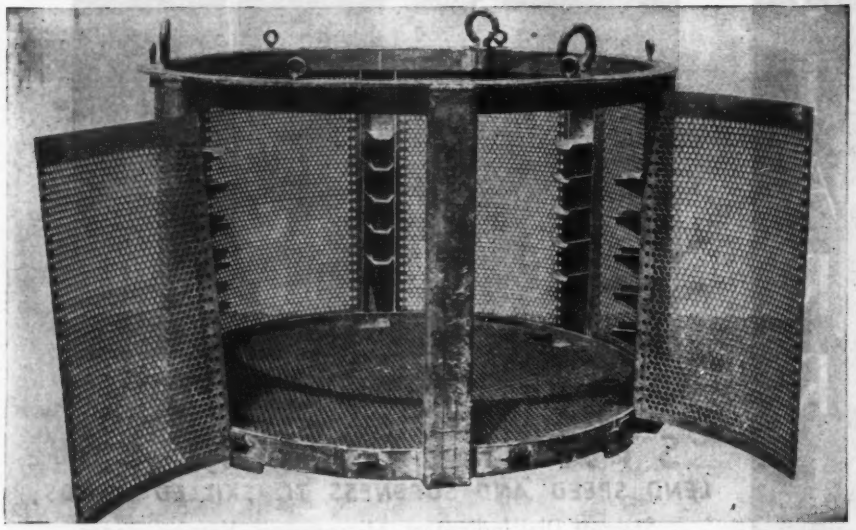

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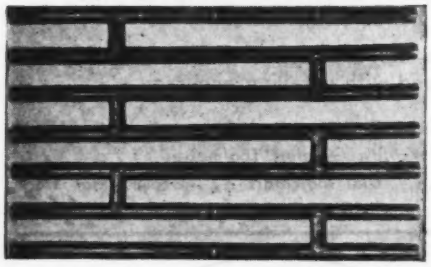

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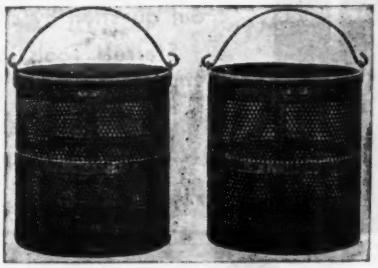

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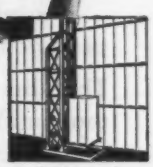
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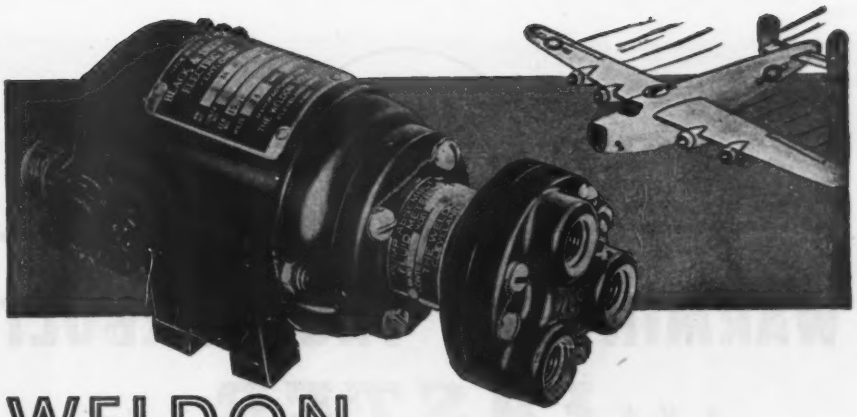

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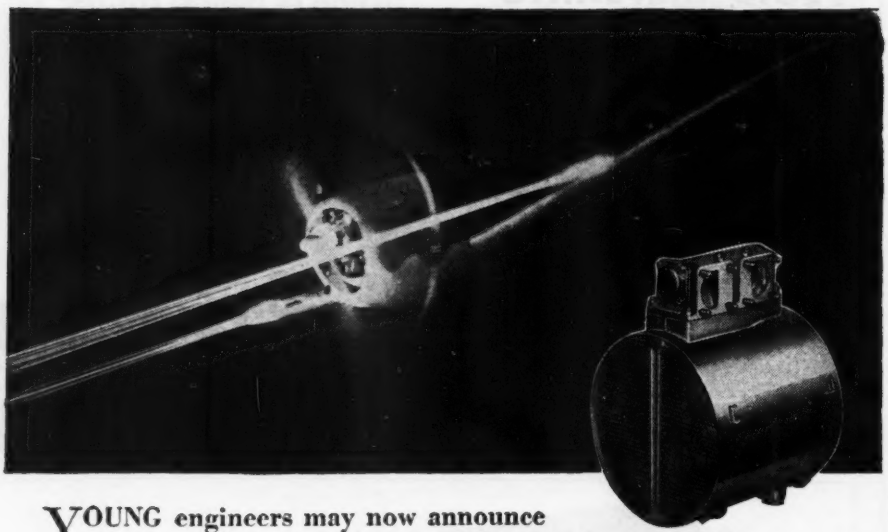

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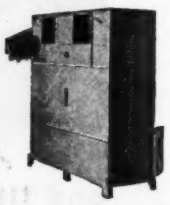

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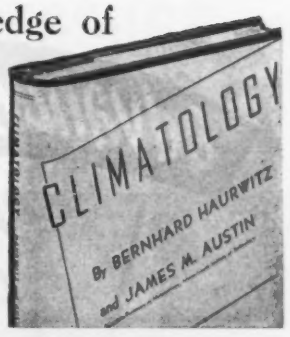
Get a sound knowledge of **climatology**

from this concise, practical book



Here is a fundamental treatment of the principles of climatology and the distribution of the climates of the earth. Physical causes and variation in space and time have been stressed with special attention being paid to Köppen's classification of climatic types. More than half the book is given over to detailed discussion and data on specific regions in terms of dynamics of the atmosphere, air mass types, and frontal activity.

CLIMATOLOGY

By BERNHARD HAURWITZ *and* JAMES M. AUSTIN

Associate Professors of Meteorology, Massachusetts Institute of Technology

410 pages, 6 x 9, illustrated, $4.50

THE first part of this book deals with the various meteorological elements, their distribution over the globe, and their seasonal and diurnal variations, together with the factors determining these variations. In view of their important bearing on the physics of the climate, conditions in the upper atmosphere are discussed whenever observations are available.

The second part of the book gives detailed treatment to the climates of particular regions from the standpoint of topography, ocean currents, wind regime, air masses, fronts, cyclones, and anticyclones.

Climatological data from over five hundred different stations is included, together with numerous tables and graphs. The material will be equally useful to readers wanting a background in the fundamental principles of climatology and to those who desire specific information about the climate of a particular region.

CONTENTS

1. Solar Radiation and Terrestrial Heat Balance
2. Temperature
3. Wind and Pressure
4. Hydrometeors
5. Air Masses, Fronts, Cyclones, and Anticyclones
6. Climate Zones and Types
7. Description of the Climatic Types
8. Microclimatology
9. North and Central America
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Numerical values of the boundaries between climatic types and their distribution

Variations in microclimate caused by small elevations, slope of the ground, vegetation

Circulation paths of tropical cyclones

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Factors determining the climatic regions of each continent

Frequency and favorable conditions for radiation fogs

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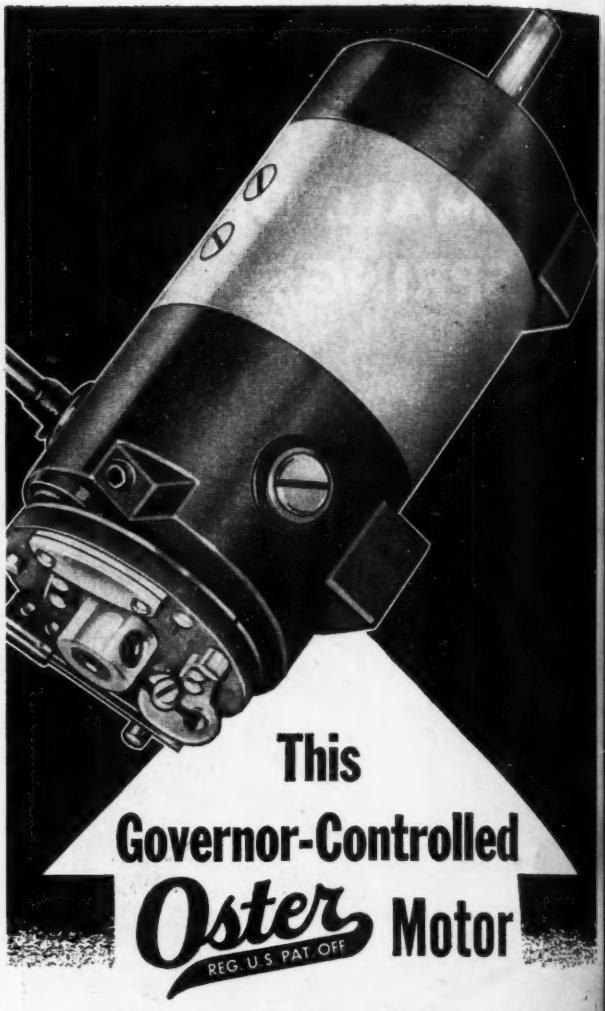

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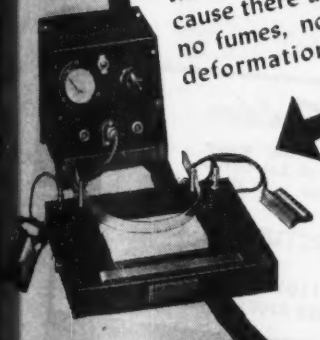

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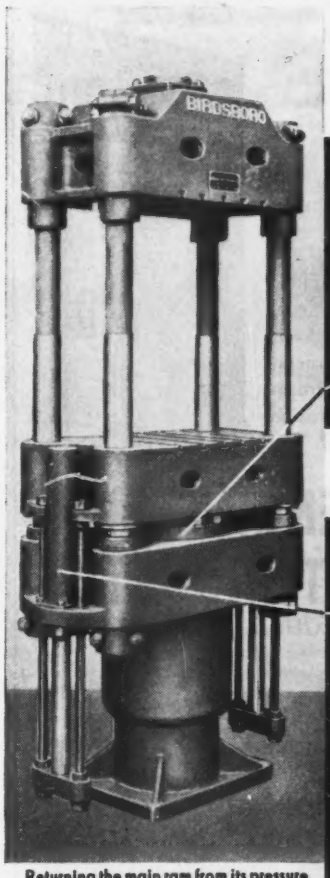

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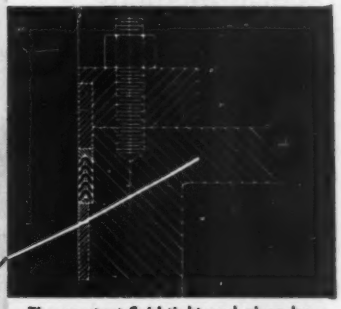
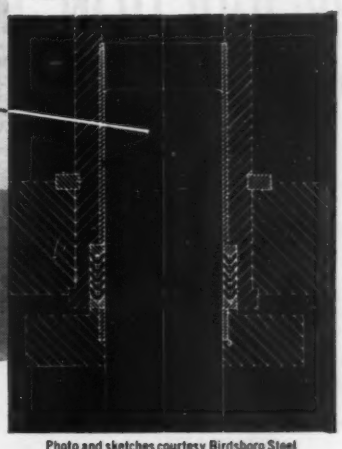


The constant fluid-tight seal given by Linear "Par" packings aids this 18" diameter ram to operate at top efficiency.



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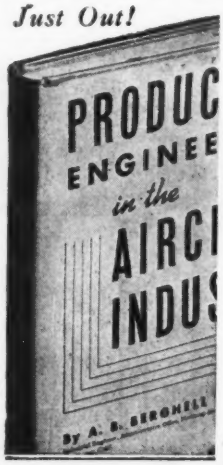

Here is a book planned especially as an aid in solving common production problems in the aircraft industry. Through the use of specific cases, questions, and answers, the author explains the application of principles of estimating new contract costs, budgeting and scheduling direct labor hours, controlling work in process through time standards, work simplification, material saving, and the preparation of statistical and graphical reports.

PRODUCTION ENGINEERING in the AIRCRAFT INDUSTRY

By A. B. BERGHELL

Industrial Engineer, Administrative Office, Northrop Aircraft, Inc., Hawthorne, California

307 pages, 6 x 9, illustrated, $3.00

This practical text, unique in the field, emphasizes the development of reliable standards and methods of utilizing them in controlling production through determining the causes of variation. In this way the production engineer is enabled to eliminate difficulties and increase efficiency. Considerable attention is given to the organization of work on assembly lines and its scheduling and control during assembly operations. The material covers the use of time standards and the principles of their application to fabricating, machine and assembly operations; principles of work simplification; suggestion systems; process and flow charts; operational sequences, instruction cards and the organization of work in major assembly, subassembly and fabricating departments; material saving; determination of direct labor costs and their presentation through statistical reports and graphs; control of direct labor hours and costs through cumulative total graphs, arithmetic, ratio and log-log graphs; estimating the direct labor hours required for new contracts; through the use of shop loading and contract budgeting; and relations with management and shop.

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VII. Material Saving
VIII. Determination of Direct Labor Costs and Their Presentation through Statistical Reports and Graphs
IX. Control of Direct Labor Hours and Costs through Cumulative Total Graphs on Arithmetic Paper and Moving Averages
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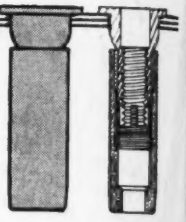
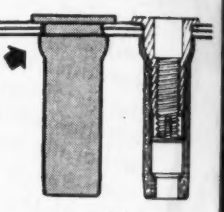
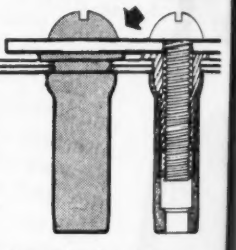


3 Riveted securely by drawing sleeve against inner side of metal with special power or hand tool.



4 Attachment fastened by screw locked in anchor nut.



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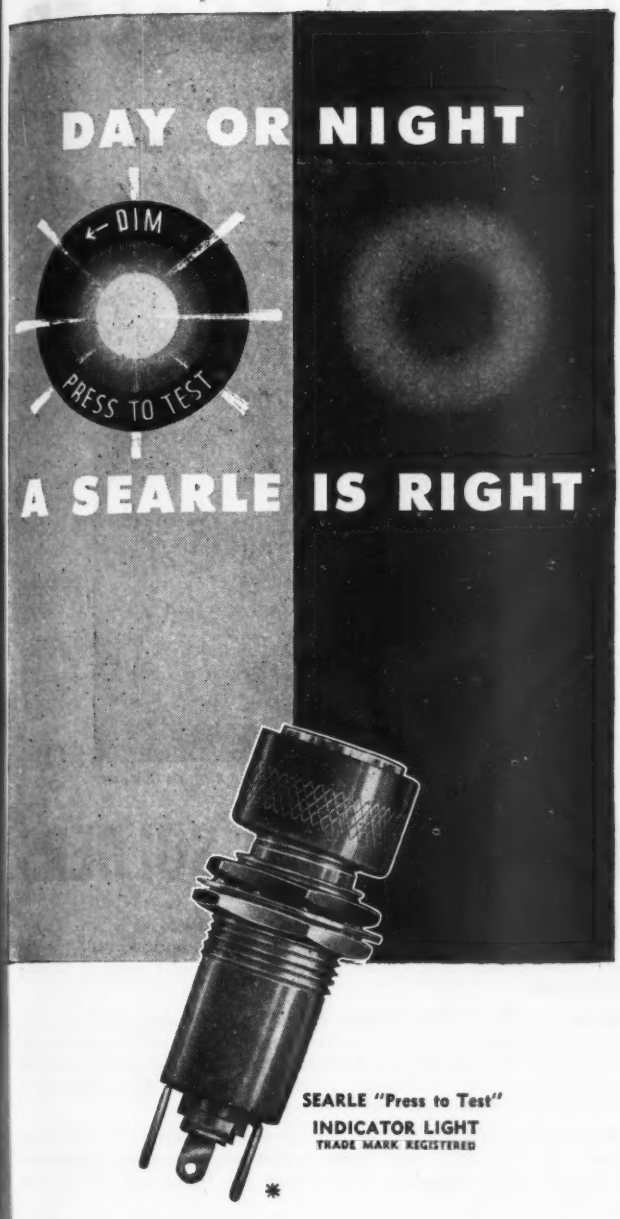

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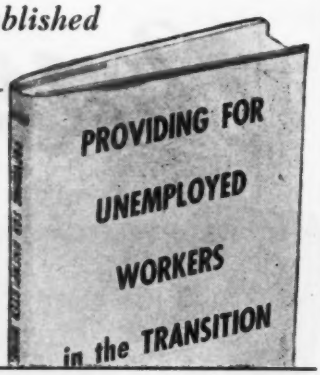

PROVIDING FOR UNEMPLOYED WORKERS in the TRANSITION

By RICHARD A. LESTER

Associate Professor of Economics, Duke University

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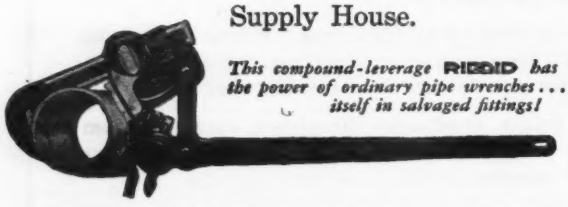

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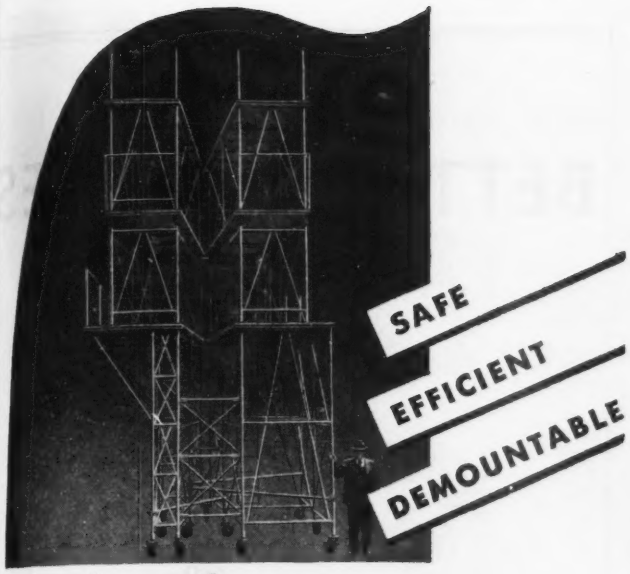

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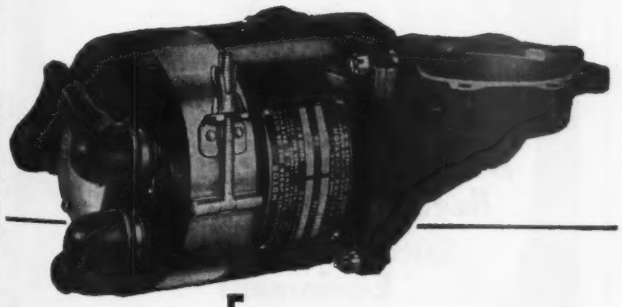

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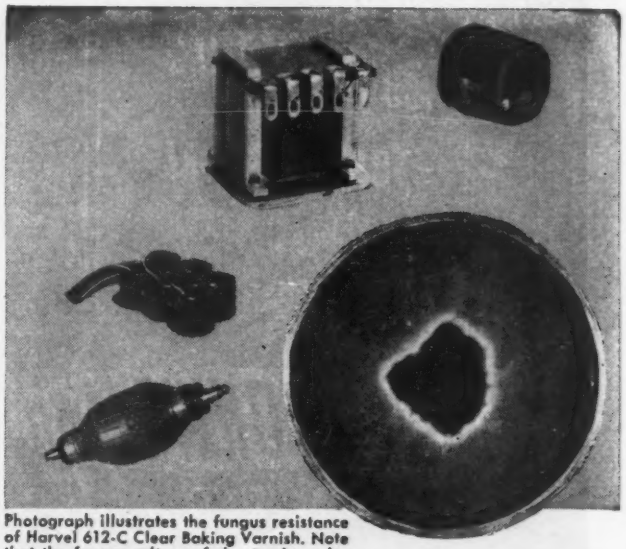

Photograph illustrates the fungus resistance of Harvel 612-C Clear Baking Varnish. Note that the fungus culture of chaetomium globosum has not attacked the sample film of Harvel 612-C.

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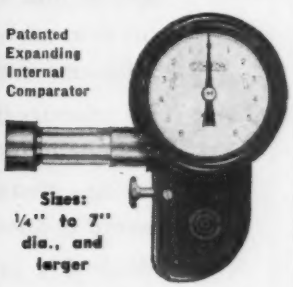

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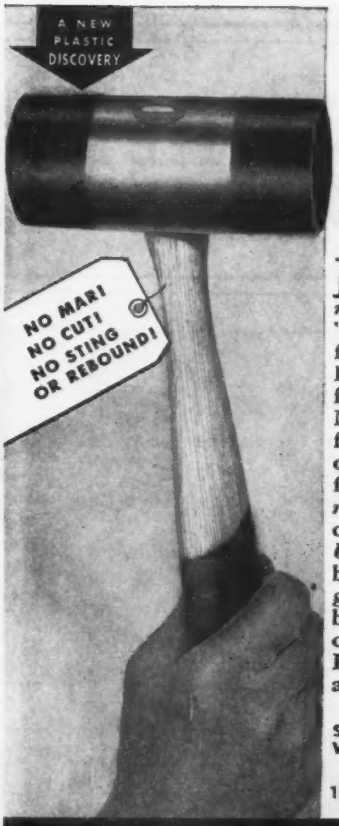

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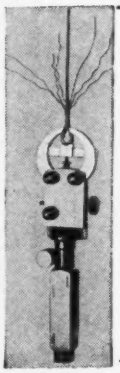

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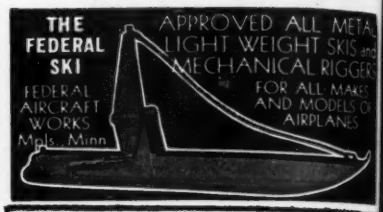
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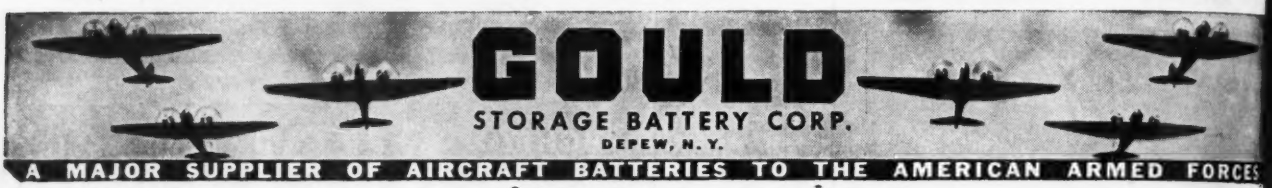

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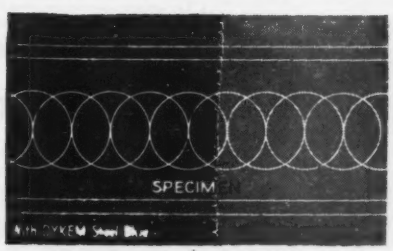

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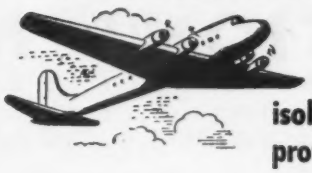

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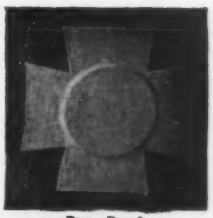

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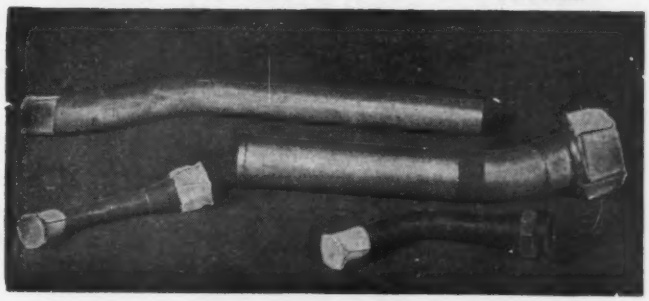

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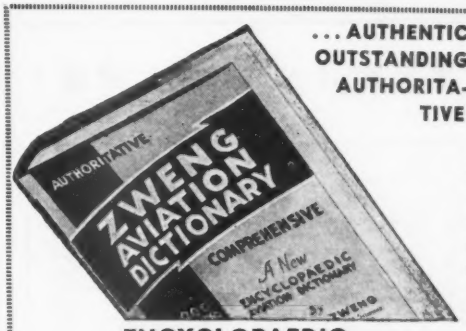

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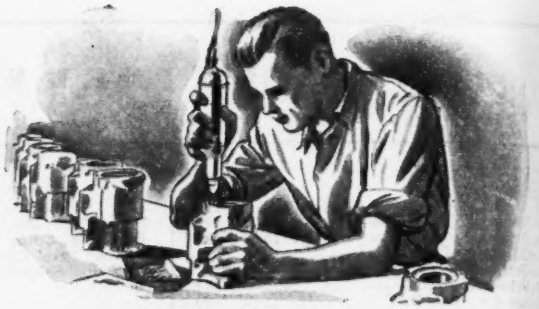

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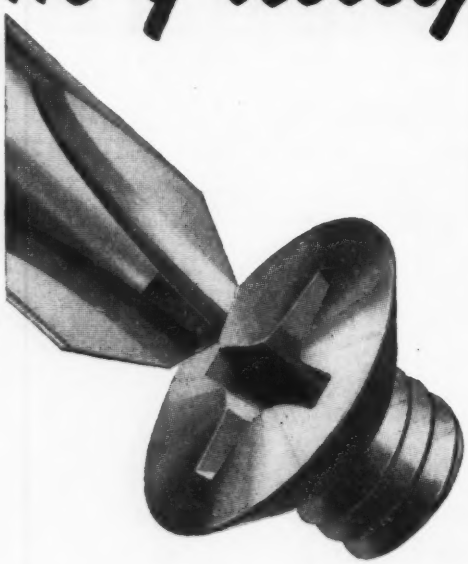

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